Integrated Water Flow Model
(IWFM v2.3)

User's Manual

Hydrology Development Unit
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Bay-Delta Office
September, 2005

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1. Introduction

The purpose of the IWFM user's manual is to serve as a guide for populating input files, running IWFM and understanding the model results. This chapter briefly describes IWFM and the development of the model. A summary of this manual is included in this chapter to help guide the user when working with IWFM.

1.1. IWFM Description

IWFM is a Fortran procedural code written in both Fortran 77 and Fortran 95 languages. The model is comprised of a pre-processor, simulation component and post-processors (Figure 1.1). IWFM must be run sequentially and the output generated from one program must be transferred to the next before beginning a model run.

1.2. Summary of IWFM User's Manual

Chapter 1	Introduction
Chapter 2	Descriptions of the pre-processor subroutines, input files and output files presented in this chapter
Chapter 3	Details of the subroutines included in the simulation program as well as input data files and output files generated
Chapter 4	Descriptions of the budget tables and the required input needed to tabulate simulation results

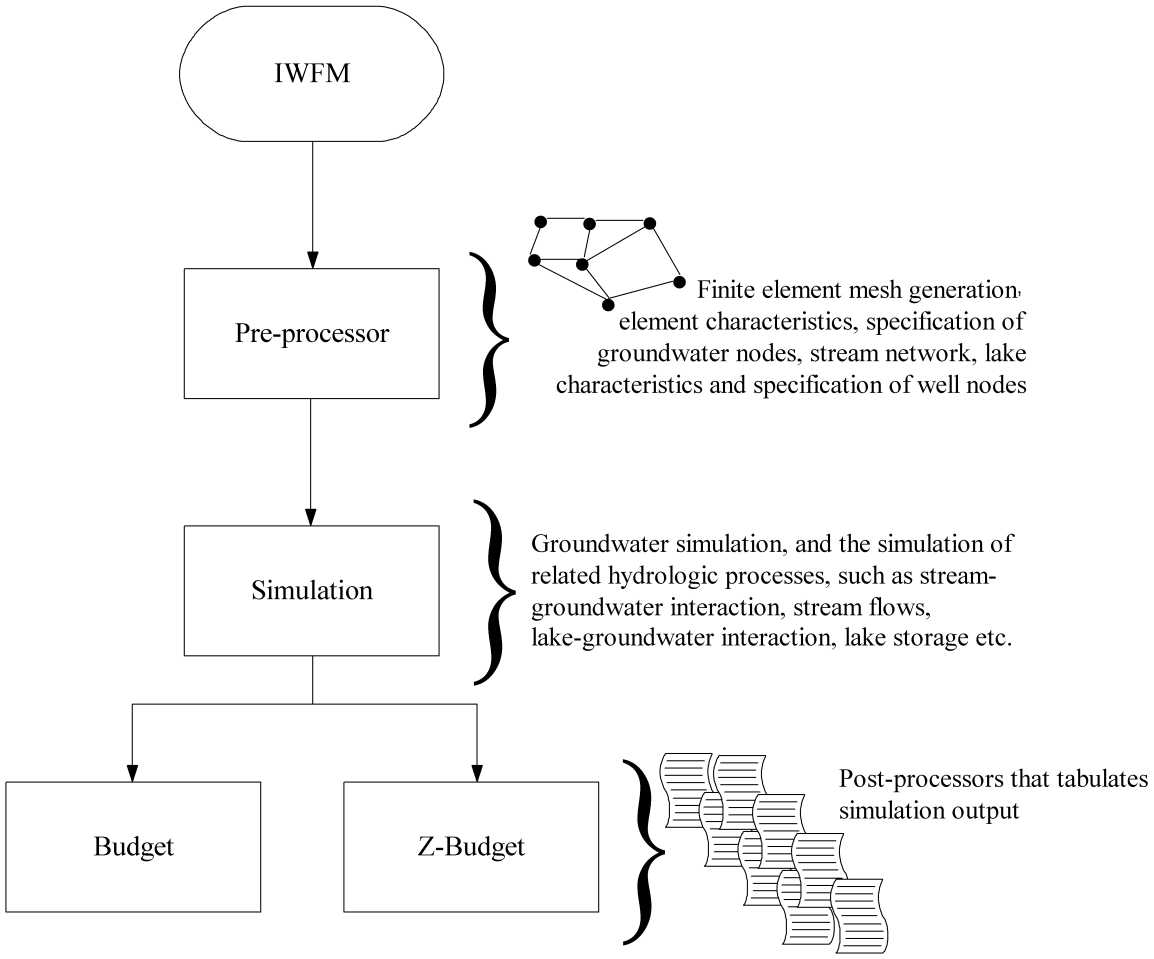


Figure 1.1 IWFM program structure

Chapter 5 Step-by-step guide of how to run IWFM, which includes running the pre-processor, simulation and budget portions of the program

2. Pre-Processor

The pre-processor is the first portion of IWFM that is executed when running the model. The program compiles time-independent data such as the spatial, hydrologic, and stratigraphic characteristics specific to a simulation project. Specification of the finite element mesh, element soil characteristics, stratigraphy, stream network, lakes and wells within the model domain are processed in this part of IWFM. This chapter gives a description of the pre-processor subroutines, input and output file descriptions and sample input and output files.

2.1. Subroutine Descriptions

The pre-processor is a procedural FORTRAN program, and consists of a main program and subroutines (Figure 2.1). This section describes each subroutine included in the pre-processor program.

Iwfm_f1 The main program, which reads the main pre-processor input file (Unit 5). Iwfm_f1.for generates a binary and ASCII output file. The binary file contains information necessary to run the model simulation. The ASCII output displays processed data read by the pre-processor.

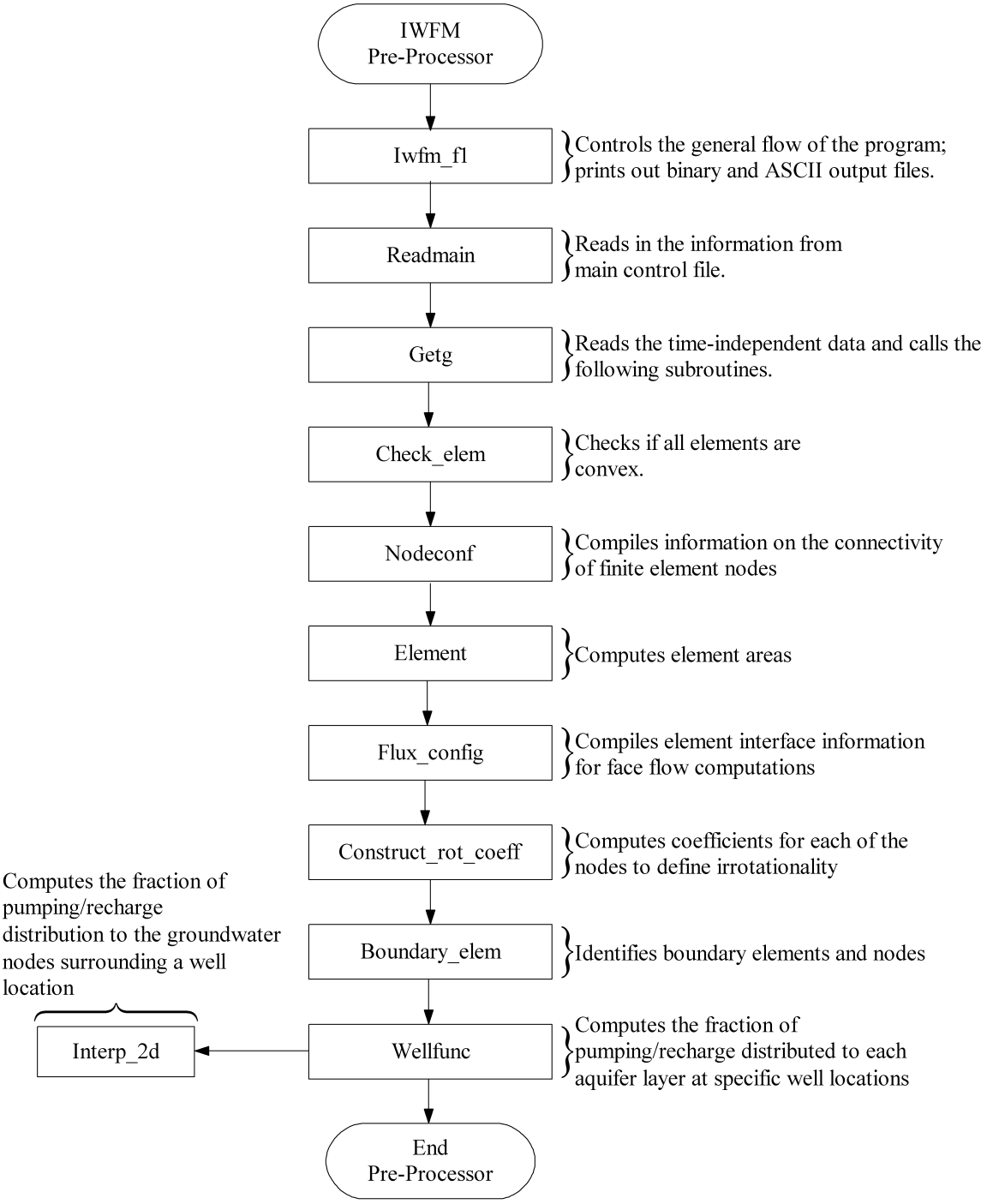


Figure 2.1 IWFM pre-processor subroutines

Readmain This subroutine opens and reads in the title of project, file names, output options and output conversion factors from the main input file.

Getg This subroutine reads and processes the time-independent input data. The time independent data read in Getg is as follows: Nodal x and y coordinates, stratigraphy of groundwater layers, stream network, lake characteristics, well locations and characteristics, and element characteristics. Getg also establishes the JND and NJD arrays that are used to store the non-zero components of coefficient matrix and row-column locations.

Check_elem This subroutine checks that all finite elements are convex, i.e. the internal angles at each node of an element are larger than 180 degrees.

Nodeconf This subroutine compiles information based on the finite element nodes specified in the nodal coordinate data file (Unit 8) to be used for compact storage of matrices and vectors used in the solution of the quasi three-dimensional groundwater equation.

Element This subroutine calculates elemental areas based on the nodal coordinates specified in Unit 8.

Flux_config This subroutine numbers each of the element interfaces and identifies the interface numbers that meet at each finite element node. This information is used in Simulation in computing the flow rates through element interfaces.

Construct_rot_coeff This subroutine computes the relevant coefficients to define the irrotationality of the flow field at a closed path around each finite element node.

Boundary_elem This subroutine identifies the element numbers and corresponding element faces that lie on the entire modal and the subregional boundaries.

Wellfunc This subroutine determines the fractions to vertically distribute the pumping/recharge to each aquifer layer.

Interp_2d This is the interpolation routine that computes the relative proportion of pumping distributed to the groundwater nodes surrounding the well location.

2.2. Input Files

This section consists of input file explanations, the description of variables in each pre-processing input file and sample input files. The user should not judge input file spacing based on the sample input files provided in this documentation, instead refer to the input files from a copy of IWFM.

Table 2.1 specifies the input files that contain required and optional data to run the pre-processing portion of IWFM. The status is based on the input files required to simulate groundwater flow with IWFM, versus groundwater flow simulation in conjunction with other model features, such as stream flows, and lakes.

Pre-Processor Main Input File **Unit 5**

The main input file allows a maximum of three lines for a title that is printed to

File	Description	Status
Unit 5	Main input file	Required
Unit 7	Element and node specification	Required
Unit 8	Spatial location of all nodes	Required
Unit 9	Composition of groundwater layers	Required
Unit 10	Stream configuration	Optional
Unit 11	Lake configuration	Optional
Unit 12	Well locations and characteristics	Optional
Unit 13	Hydrologic characteristics of each element	Required

Table 2.1 List of IWFM pre-processor input files

the ASCII output file (Unit 6). 'C', 'c', or '*' should not be in the first column of any of the title lines. All pre-processor input file names are read from the main input file and associated with a unit number within the program. All input and output file names must be no more than 50 characters long, and each file name must be within the first 50 columns. Simply leave any file name specification columns blank if an input file is not used. Groundwater simulation requires element configuration data (Unit 7), nodal coordinate data (Unit 8), stratigraphy (Unit 9), and element characteristics (Unit 13). The pre-processor can output all units of length and area, given that the user specifies the conversion factor from simulation units to output units of length and area. The following list represents each input variable specified in Unit 5:

KOUT	Option to print time-independent data read by the pre-processor program
KDEB	This print option allows the user to print program messages on the screen during execution of the pre-processor or print the non-zero finite element stiffness matrix components
FACTLTOU	Factor to convert simulation unit of length to the user specified output unit of length
UNITLTOU	The output unit of length, described in a maximum of 10 characters
FACTAROU	Factor to convert simulation unit of area to the user specified output unit of area
UNITAROU	The output unit of area, described in a maximum of 10 characters

```
C*******************************************************************************
C
C                    INTEGRATED WATER FLOW MODEL (IWFM)
C                          *** Version ### ***
C
C*******************************************************************************
C
C                             MAIN INPUT FILE
C                          for IWFM Pre-Processing
C                                 (Unit 5)
C
C
C             Project:  IWFM Version ### Release
C                       California Department of Water Resources
C             Filename: MAIN.IN1
C
C*******************************************************************************
C                      Titles Printed in the Output
C
C   *A Maximum of 3 title lines can be printed.
C   *Do not use '*' , 'c' or 'C' in the first column.
C
C                             *********************
                                    IWFM
                               Version ### Release
                                      DWR
C                             *********************
C*******************************************************************************
C                               File Description
C
C  *Listed below are all input and output file names used when running the
C   pre-processor for IWFM.
C
C  *Each file name has a maximum length of 50 characters
C
C  *If a file does not exist for a project, leave the filename blank
C   For example, if lakes are not modeled in the project, the file name and
C   description columns for unit 11 will appear as:
C
C   FILE NAME                                       UNIT DESCRIPTION
C                                                   /11: LAKE DATA
C-------------------------------------------------------------------------------
C   FILE NAME                                       UNIT DESCRIPTION
C-------------------------------------------------------------------------------
   OUTPUT1.BIN                                      / 4: BINARY OUTPUT FOR SIMULATION (OUTPUT, REQUIRED)
   MAIN.IN1                                         / 5: CONTROL INPUT FILE (INPUT, REQUIRED)
   OUTPUT1.OUT                                      / 6: STANDARD OUTPUT FILE (OUTPUT, REQUIRED)
   ELEMENT.DAT                                      / 7: ELEMENT CONFIGURATION FILE (INPUT, REQUIRED)
   XY.DAT                                           / 8: NODE X-Y COORDINATE FILE (INPUT, REQUIRED))
   STRATA.DAT                                       / 9: STRATIGRAPHIC DATA FILE (INPUT, REQUIRED))
   STREAM.DAT                                       /10: STREAM GEOMETRIC DATA FILE (INPUT, OPTIONAL)
   LAKE.DAT                                         /11: LAKE DATA FILE (INPUT, OPTIONAL)
                                                    /12: WELL DATA FILE (INPUT, OPTIONAL)
   ELEMCHRC.DAT                                     /13: ELEMENT CHARACTERISTIC DATA FILE (INPUT, REQUIRED)
C-------------------------------------------------------------------------------
C*******************************************************************************
C                    Pre-Processor Output Specifications
C
C    KOUT; Enter 1 - Print geometric and stratigraphic information
C          Enter 0 - Otherwise
C
C    KDEB; Enter 2 - Print messages on the screen during program execution
C          Enter 1 - Print non-zero Finite Element Stiffness Matrix Components
C          Enter 0 - Otherwise
C-------------------------------------------------------------------------------
C  VALUE                        DESCRIPTION
C-------------------------------------------------------------------------------
     1                           /KOUT
     1                           /KDEB
C-------------------------------------------------------------------------------
C*******************************************************************************
C                  Unit Specifications of Pre-Processor Output
C
C    FACTLTOU; Factor to convert simulation unit of length to specified output unit of length
C    UNITLTOU; The output unit of length (maximum of 10 characters)
C    FACTAROU; Factor to convert simulation unit of area to specified output unit of area
C    UNITAROU; The output unit of area (maximum of 10 characters)
C
C-------------------------------------------------------------------------------
C   VALUE                        DESCRIPTION
C-------------------------------------------------------------------------------
    1.0                          /FACTLTOU
    FEET                         /UNITLTOU
    0.000022957                  /FACTAROU
    ACRES                        /UNITAROU
```

Element Configuration File **Unit 7**

Unit 7 details the element configuration for each element represented in the finite element mesh. Each element is configured from three or four nodal points. All elements that represent the model domain are either triangular or quadrilateral. A zero value for IDE(4) indicates that the element is triangular. Nodes corresponding to each element are specified in a counterclockwise manner. Element size should be based on observed or predicted groundwater head gradients throughout the model domain. Therefore, in areas where the flux is large, the size of the elements should be smaller than those located in areas of relatively small flow gradients. The following variables are required as input in Unit 7:

NE	Number of elements within the model domain
IE	Element number
IDE	Nodes corresponding to each element number; 3 nodes are associated with each triangular element (4^{th} node should be set to zero) and 4 nodes are associated with each quadrilateral element

```
C*******************************************************************************
C
C                    INTEGRATED WATER FLOW MODEL (IWFM)
C                          *** Version ### ***
C
C*******************************************************************************
C
C                        ELEMENT CONFIGURATION FILE
C                         for IWFM Pre-Processing
C                                (Unit 7)
C
C
C             Project:  IWFM Version ### Release
C                       California Department of Water Resources
C             Filename: ELEMENT.DAT
C
C*******************************************************************************
C                             File Description
C
C   This file  contains the element configuration for each element.
C   The nodes that make a finite element are listed for each element in
C   a counter-clock wise fashion starting with any node. For triangular elements,
C   the fourth node is specified as zero.
C
C
C   For example,
C
C                    13-------------14----------17
C                     I              I         I
C                     I      2       I   3   I
C                     I              I     I
C                     I              I   I
C                    15------------- 16
C
C
C   The configuration for elements 2 and 3 will be listed as,
C
C            element   node 1    node 2    node 3   node 4
C               2        13        15        16        14
C               3        14        16        17         0
C
C*******************************************************************************
C                      Element Configuration Data
C
C    NE;    Number of elements within the model domain
C-------------------------------------------------------------------------------
C   VALUE                          DESCRIPTION
C-------------------------------------------------------------------------------
    400                            /NE
C-------------------------------------------------------------------------------
C*******************************************************************************
C
C   The data listed below represents all elements and corresponding nodes
C   within the model domain.
C
C   IE;      Element number
C   IDE;     Nodes corresponding to each element
C            *Note* IDE(4) is zero for all triangular elements
C
C-------------------------------------------------------------------------------
C   Element     ------------Corresponding Nodes------------------
C   IE          IDE(1)        IDE(2)       IDE(3)       IDE(4)
C-------------------------------------------------------------------------------
     1           1             2           23           22
     2           2             3           24           23
     3           3             4           25           24
     4           4             5           26           25
     5           5             6           27           26
     .           .             .           .            .
     .           .             .           .            .
     .           .             .           .            .
     397         416           417         438          437
     398         417           418         439          438
     399         418           419         440          439
     400         419           420         441          440
```

Nodal X-Y Coordinate File Unit 8

The nodal coordinate file contains each node number and corresponding x and y coordinates (in relation to a specific origin). Any coordinate units may be used as long as the appropriate conversion factor is given. This file sets up the spatial orientation of the groundwater nodes in the model domain. The finite element mesh is generated from the nodal coordinates, as well as relationship between elements and corresponding groundwater nodes (refer to Unit 7).

ND	Number of groundwater nodes
FACT	Factor to convert nodal coordinates to simulation unit of length
ID	Groundwater node identification number
X	x-coordinate of groundwater node location
Y	y-coordinate of groundwater node location

```
C*******************************************************************************
C
C                    INTEGRATED WATER FLOW MODEL (IWFM)
C                           *** Version ### ***
C
C*******************************************************************************
C
C                        NODAL X-Y COORDINATE FILE
C                         for IWFM Pre-Processing
C                               (Unit 8)
C
C
C             Project:  IWFM Version ### Release
C                       California Department of Water Resources
C             Filename: XY.DAT
C
C*******************************************************************************
C                            File Description
C
C   *This file includes all groundwater nodes that represent the model domain,
C    as well as the x and y coordinates that correspond with each node.
C
C   *The coordinates can be specified for any reference point and coordinate
C    system
C
C   *The conversion factor must be specified in order to convert the units
C    of the coordinate system to feet.
C
C*******************************************************************************
C                     Groundwater Node Specifications
C
C   ND;    Number of groundwater nodes
C   FACT;  Conversion factor for nodal coordinates
C-------------------------------------------------------------------------------
C   VALUE                          DESCRIPTION
C-------------------------------------------------------------------------------
    441                            /ND
    1.0                            /FACT
C-------------------------------------------------------------------------------
C*******************************************************************************
C                       Groundwater Node Locations
C   The following lists the node number and x & y coordinate of each node
C
C   ID;   Groundwater node number
C   X,Y;  Coordinates of groundwater node location [L]
C
C-------------------------------------------------------------------------------
C   Node     ----------Coordinates----------
C    ID            X                   Y
C-------------------------------------------------------------------------------
      1         0.0                 0.0
      2         2000.0              0.0
      3         4000.0              0.0
      4         6000.0              0.0
      5         8000.0              0.0
      .         .                   .
      .         .                   .
      .         .                   .
    437         32000.0             40000.0
    438         34000.0             40000.0
    439         36000.0             40000.0
    440         38000.0             40000.0
    441         40000.0             40000.0
```

Stratigraphy File **Unit 9**

The stratigraphy data represents the composition, distribution, and succession of aquifer layers. Each aquifer layer can be classified as confined or unconfined. For a confined layer, information must be provided about confining layer (aquiclude or aquitard). The data file specifies each aquifer layer. The conversion factor in the data file converts elevations and thicknesses to simulation unit of length. Each groundwater node, the ground surface elevation at the groundwater node, and the thickness of each layer (and corresponding confining layer) at each node are required stratigraphy input data.

If the thickness of the aquiclude or aquitard is set to zero, there is no separating confining layer that distinguishes an aquifer layer from the adjacent layer. If thickness of an aquifer layer is set to zero, this implies that the groundwater node at that aquifer layer is an inactive node and the aquifer layer does not exist at that location. The following input is required in the stratigraphy data file:

NL	Number of groundwater layers modeled in IWFM; each layer consists of an aquifer and aquiclude or aquitard
FACT	Factor to convert stratigraphic data from user input units to the simulation unit of length
ID	Groundwater node
ELV	Ground surface elevation relative to a common datum, [L]

W	Thickness of the aquifer layer, and its confining layer (if the layer is confined). If the layer is unconfined, specify the aquitard thickness as zero

```
C*******************************************************************************
C
C                    INTEGRATED WATER FLOW MODEL (IWFM)
C                          *** Version ### ***
C
C*******************************************************************************
C
C                          STRATIGRAPHY FILE
C                       for IWFM Pre-Processing
C                            (Unit 9)
C
C
C             Project:  IWFM Version ### Release
C                       California Department of Water Resources
C             Filename: STRATA.DAT
C
C*******************************************************************************
C                           File Description
C
C   This data file contains:
C   *the ground surface elevation,
C   *the number of aquifer layers to be modeled, and
C   *the thickness of each aquifer and corresponding confining layer (if any)
C   at each groundwater node within the model domain.
C
C*******************************************************************************
C                     Stratigraphy Specification Data
C
C   NL;    Number of layers to be modeled
C   FACT;  Conversion factor for stratigraphic data
C-------------------------------------------------------------------------------
C   VALUE                           DESCRIPTION
C-------------------------------------------------------------------------------
    2                              /NL
    1.0                            /FACT
C-------------------------------------------------------------------------------
C*******************************************************************************
C                           Stratigraphy Data
C
C  *The stratigraphy data represents the geology that deals with the origin,
C   composition, distribution and succession of groundwater layers.
C
C  *Each groundwater layer is specified as an aquifer and aquiclude or aquitard.
C   If there is no aquiclude or aquitard within the layer, specify a thickness
C   of zero
C
C  *The stratigraphy data includes the ground surface elevation, as well as the
C   thickness of the aquifer, aquitard, or aquiclude at each groundwater node
C
C   ID;      Groundwater node
C   ELV;     Ground surface elevation with respect to a common datum; [L]
C   W(1);    Thickness of aquiclude in Layer 1; [L]
C   W(2);    Thickness of aquifer in Layer 1; [L]
C   W(3);    Thickness of aquiclude in Layer 2; [L]
C   W(4);    Thickness of aquifer in Layer 2; [L]
C   W(5);    Thickness of aquiclude in Layer 3; [L]
C   W(6);    Thickness of aquifer in Layer 3; [L]
C
C-------------------------------------------------------------------------------
C    Node  Elevation   --Layer #1--     --Layer #2--     --Layer #3--   ...
C     ID     ELV        W(1)   W(2)     W(3)    W(4)      W(5)    W(6)  ...
C-------------------------------------------------------------------------------
       1    500.0       0.0    500.0    10.0    100.0
       2    500.0       0.0    500.0    10.0    100.0
       3    500.0       0.0    500.0    10.0    100.0
       4    500.0       0.0    500.0    10.0    100.0
       5    500.0       0.0    500.0    10.0    100.0
       .    .           .      .         .      .
       .    .           .      .         .      .
       .    .           .      .         .      .
     436    500.0       0.0    500.0     0.0    100.0
     437    500.0       0.0    500.0     0.0    100.0
     438    500.0       0.0    500.0     0.0    100.0
     439    500.0       0.0    500.0     0.0    100.0
     440    500.0       0.0    500.0     0.0    100.0
     441    500.0       0.0    500.0     0.0    100.0
```

Stream Configuration File Unit 10

Stream flow is modeled using one-dimensional line segments. The stream configuration data file contains all of the stream nodes and spatial orientation. The data file includes the stream network configuration, which is specified for each reach. Following the stream reach data is the rating table for each of the stream nodes. Based on the rating table values, interpolation is used to determine the stream flow for a specific stream elevation. The following parameters must be specified at the beginning of the stream configuration file for the simulation of stream flows:

NRH	Number of stream reaches modeled
NR	Number of stream nodes modeled
NRTB	Number of data points in each rating table. A rating table is given for each stream node specified within the model domain

Stream Reaches

For each reach of a river, the following items are specified: reach identification number (ID), first upstream node of reach ID, last downstream node of reach ID, and the stream node that reach ID flows into. The stream nodes are then listed, followed by the groundwater node that the stream node corresponds to, and the subregion that the stream node belongs to. The subregion listed for a stream node does not have to be the one that the node physically resides. The subregion numbers are used solely for grouping and reporting the simulation output. For instance, a particular stream node may physically

reside in one subregion but, for operational or management purposes, it may be reported in another subregion.

If flow from a stream reach contributes to a lake, then the lake number preceded by a negative sign should be entered for variable IDWN. The lake numbers are listed in the lake data file. Such a set-up is different than a set-up where recoverable losses from a by-pass (see Simulation part of this manual) flow into a lake. By-pass flows are computed before stream-groundwater interaction is calculated. In the former case, all flows at the reach, including the stream-groundwater interaction, will contribute to lake storage. However, in the latter case, stream-groundwater interaction will be excluded from the amount of flow that contributes to the lake.

The following parameters are specified in the stream reach specification portion of Unit 10:

ID	Reach identification number
IBUR	First upstream node of reach ID
IBDR	Last downstream node of reach ID
IDWN	Stream node that reach ID flows into (enter zero if stream flow leaves the modeled area; enter –nlk if stream flow enters lake number nlk)
IRV	Stream node number
IGW	Groundwater node that the stream node IRV corresponds to
IRGST	Subregion that the stream node IRV belongs to

Rating Table

Each stream node and corresponding stream bottom elevation are specified in this file, along with a rating table for each stream node that specifies the flow rate for various stream elevations. The purpose of a rating table is to determine stream flow rate, given a specific stream elevation. Factors to convert stream depths and stream bottom elevations to simulation unit of length and stream flows to simulation unit of flow rate are required.

FACTLT	Factor to convert stream bottom elevation and depth to simulation unit of length
FACTQ	Factor to convert rating table flow rates into simulation unit of flow rates
ID	Stream node number
BOTR	Stream bottom elevation relative to a common datum, [L]
HRTB	Stream depth, [L]
QRTB	Flow rate at stream depth HRTB, [L^3/T]

```
C*******************************************************************************
C
C                    INTEGRATED WATER FLOW MODEL (IWFM)
C                          *** Version ### ***
C
C*******************************************************************************
C
C                       STREAM SPECIFICATION FILE
C                        for IWFM Pre-Processing
C                              (Unit 10)
C
C
C             Project:  IWFM Version ### Release
C                       California Department of Water Resources
C             Filename: STREAM.DAT
C
C*******************************************************************************
C                              File Description
C
C   *All stream/river nodes modeled in IWFM are specified with respect to their
C    corresponding groundwater nodes
C
C   *A flow versus depth rating table is specified for each stream node
C
C*******************************************************************************
C                       Stream Reach Specifications
C
C   NRH;   Number of stream reaches modeled
C   NR;    Number of stream nodes modeled
C   NRTB;  Number of data points in stream rating tables
C
C-------------------------------------------------------------------------------
C   VALUE                         DESCRIPTION
C-------------------------------------------------------------------------------
    3                             / NRH
    23                            / NR
    5                             / NRTB
C-------------------------------------------------------------------------------
C*******************************************************************************
C                       Description of Stream Reaches
C
C   The following lists the stream nodes and corresponding groundwater
C   nodes for each stream reach modeled in IWFM.
C
C   ID;    Reach number
C   IBUR;  First upstream stream node of the reach
C   IBDR;  Last downstream node of the reach
C   IDWN;  Stream node into which the reach flows into
C              0: If stream flow leaves the modeled area
C           -nlk: If stream flows into lake number nlk
C
C   In addition, for each stream node within the reach the corresponding
C   groundwater node and subregion number is listed.
C
C   IRV;   Stream node
C   IGW;   Corresponding groundwater node
C   IRGST; Corresponding subregion number
C
C-------------------------------------------------------------------------------
C     REACH  1
C   Reach  Upstream  Downstream  Outflow
C            Node       Node      Node
C   ID       IBUR       IBDR      IDWN
C-------------------------------------------------------------------------------
     1         1          10       -1
C-------------------------------------------------------------------------------
C   Stream  Groundwater  Subregion
C   node      node       number
C   IRV       IGW        IRGST
C-------------------------------------------------------------------------------
     1       433          2
     2       412          2
     .       .            .
     .       .            .
     .       .            .
     9       265          2
    10       264          2
C-------------------------------------------------------------------------------
C     REACH 2
C   Reach  Upstream  Downstream  Outflow
C            Node       Node      Node
C   ID       IBUR       IBDR      IDWN
C-------------------------------------------------------------------------------
     2        11         16        17
C-------------------------------------------------------------------------------
C   Stream  Groundwater  Subregion
C   node      node       number
C   IRV       IGW        IRGST
C-------------------------------------------------------------------------------
    11       222          2
     .       .            .
     .       .            .
    16       139          1
C-------------------------------------------------------------------------------
C     REACH  3
C   Reach  Upstream  Downstream  Outflow
C            Node       Node      Node
C   ID       IBUR       IBDR      IDWN
C-------------------------------------------------------------------------------
     3        17         23        0
C-------------------------------------------------------------------------------
```

```
C   Stream  Groundwater  Subregion
C   node      node       number
C   IRV       IGW        IRGST
C-------------------------------------------------------------------------------
    17       139         1
     .        .          .
     .        .          .
     .        .          .
    23       13          1
C*******************************************************************************
C                             Stream rating tables
C
C   FACTLT; Conversion factor for stream bottom elevation and
C             stream depth
C   FACTQ;  Conversion factor for rating table flow rates
C
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
      1.0                       / FACTLT
      86400.0                   / FACTQ
C-------------------------------------------------------------------------------
C   The following lists a stream rating table for each of the stream nodes
C   *Note* In order to define a specified stream depth, enter all HRTB values
C             as equal to the specified depth value
C
C   ID;    Stream node number
C   BOTR;  Stream bottom elevation relative to a common datum; [L]
C   HRTB;  Stream depth; [L]
C   QRTB;  Flow rate at stream depth HRTB; [L^3/T]
C
C-------------------------------------------------------------------------------
C   Stream    Bottom   Stream      Flow
C   node     elevation  depth      rate
C   ID         BOTR     HRTB       QRTB
C-------------------------------------------------------------------------
     1       300.0     0.0       0.00
                       2.0       734.94
                       5.0       3299.29
                       15.0      19033.60
                       25.0      41568.45
     2       298.0     0.0       0.00
                       2.0       734.94
                       5.0       3299.29
                       15.0      19033.60
                       25.0      41568.45
     3       296.0     0.0       0.00
                       2.0       734.94
                       5.0       3299.29
                       15.0      19033.60
                       25.0      41568.45
     .       .         .         .
                       .         .
                       .         .
     .       .         .         .
                       .         .
                       .         .
    23       260.0     0.0       0.00
                       2.0       734.94
                       5.0       3299.29
                       15.0      19033.60
                       25.0      41568.45
```

Lake Configuration File **Unit 11**

The lake data file specifies the number of lakes modeled and the factor to convert the maximum lake elevation to simulation unit of length. Each lake is specified by an identification number. The maximum water elevation of each lake is required, followed by the identification number of the next downstream lake, the number of elements that each lake encompasses, and the element numbers that correspond to the lake region. The following lists the lake input:

NLAKE	Number of lakes modeled
NTELAKE	Total number of lake elements
FACT	Factor to convert maximum lake elevation to simulation unit of length
ID	Lake identification number
HLMAX	Maximum water elevation in lake ID, [L]
INLAKE	Lake identification number of the next downstream lake. Enter 0 (zero) if flow from lake leaves the modeled area, -nd if flow from lake goes to stream node nd, or nd if flow from lake goes to the downstream lake nd
NELAKE	Number of elements that a lake encompasses
IELAKE	Element number over which the lake is located

```
C*******************************************************************************
C
C                     INTEGRATED WATER FLOW MODEL (IWFM)
C                            *** Version ### ***
C
C*******************************************************************************
C
C                    LAKE CONFIGURATION DATA FILE
C                      for IWFM Pre-Processing
C                             (Unit 11)
C
C
C             Project:  IWFM Version ### Release
C                       California Department of Water Resources
C             Filename: LAKE.DAT
C
C*******************************************************************************
C
C                               File Description:
C
C   This data file contains the number of lakes being modeled,
C   next downstrem lake and the finite elements included in each lake.
C
C*******************************************************************************
C                   Lake Configuration Data
C
C   NLAKE  ; Number of lakes that are being modeled
C   NTELAKE; Total number of lake elements
C   FACT   ; Conversion factor for maximum lake elevation
C
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
      1                         / NLAKE
      10                        / NTELAKE
      1.0                       / FACT
C-------------------------------------------------------------------------------
C
C   The following lists the area and elevation for the NLAKE number of lakes
C
C   ID    ;  Sequential number for the lakes
C   INLAKE;  Next downstream lake number
C              0 : if flow from lake leaves the modeled area
C             -nd : if flow from lake goes to stream node nd
C              nd : if flow from lake goes to the downstream lake, nd
C   NELAKE;  Number of lake elements where lake lies
C   IELAKE;  Element in which the lake is located
C-----------------------------------------------------------------------
C   Lake No.    Next Lake  Elem per Lake   Element
C     ID          INLAKE       NELAKE        IELAKE
C-----------------------------------------------------------------------
      1           -11          10            169
                                             170
                                             171
                                             188
                                             189
                                             190
                                             207
                                             208
                                             209
                                             210
```

Well Data File **Unit 12**

The location and characteristics of wells are specified in the well data file. Similar to the nodal coordinates data file (Unit 8), each well identification number corresponds to a location based on an x and y coordinate. The x and y coordinates can be input with any units, as long as the correct conversion factor (FACTCX) is given in the file. Other required input for each well is the diameter and the elevation of the top and bottom perforations in the well. Factors to convert the diameter and elevations from input units to simulation units are also required. The following list of variables is required input data, given that pumping and recharge are defined on the basis of well locations:

NWELL	Number of wells modeled
FACTCX	Conversion factor for well coordinates
FACTRW	Factor to convert well diameter to simulation unit of length
FACTLT	Factor to convert perforation depths to simulation unit of length
ID	Well identification number
XWELL	x coordinate of well ID, [L]
YWELL	y coordinate of well ID, [L]
RWELL	Well diameter, [L]
PERFT	Elevation of the top perforation, [L]
PERFB	Elevation of bottom perforation, [L]

```
C*******************************************************************************
C
C                    INTEGRATED WATER FLOW MODEL (IWFM)
C                          *** Version ### ***
C
C*******************************************************************************
C
C                          WELL SPECIFICATION FILE
C                         for IWFM Pre-Processing
C                                (Unit 12)
C
C
C             Project:  IWFM, Version ### Release
C                       California Department of Water Resources
C             Filename: WELL.DAT
C
C*******************************************************************************
C                             File Description:
C
C   This data file includes the identification number, location(x-y coordinates),
C   radius, and depth of perforations for each well.
C
C*******************************************************************************
C              List of modeled wells and their corresponding parameters
C
C   NWELL ; Number of wells modeled
C   FACTCX; Conversion factor for well coordinates
C   FACTRW; Conversion factor for well diameter
C   FACTLT; Conversion factor for perforation depths
C
C-------------------------------------------------------------------------------
C     VALUE                         DESCRIPTION
C-------------------------------------------------------------------------------
       5                           / NWELL
       1000.0                      / FACTCX
       1.0                         / FACTRW
       1.0                         / FACTLT
C-------------------------------------------------------------------------------
C*******************************************************************************
C
C   ID;           Well identification number
C   XWELL,YWELL;  X-Y coordinates for each well; [L]
C   RWELL;        Well diameter; [L]
C   PERFT,PERFB;  Elevations of the top and bottom perforations; [L]
C
C-------------------------------------------------------------------------------
C    ID      XWELL  YWELL      RWELL       PERFT   PERFB
C-------------------------------------------------------------------------------
     1        25.0     7.0        1.0      400.0   0.0
     2        26.0    12.0        1.0      400.0   0.0
     3        25.0    19.0        1.0      400.0   0.0
     4        26.0    26.0        1.0      400.0   0.0
     5        25.0    33.0        1.0      400.0   0.0
```

Element Characteristics File **Unit 13**

The element characteristics file contains hydrologic characteristics of an element. The rainfall station and the fraction of the precipitation measured at the station determine the precipitation on an element. The rainfall station is associated with an element based on location. The rainfall factor is a weighted average of the long term mean annual precipitation at an element and the long term average annual precipitation associated with the corresponding rainfall station. If zero is entered for the rainfall stations for all the elements, then IWFM can be used to model only the groundwater system, streams and lakes without simulating any land processes (i.e. infiltration, evapotranspiration, direct runoff of precipitation and return flow of applied water). Otherwise, a non-zero station identification number must be entered for all elements.

The hydrologic soil properties of the elements are based on National Resources Conservation Service (previously known as Soil Conservation Service) soil reports. Refer to the National Engineering Handbook, Section 4 published by the USDA (1985) for more detail. NRCS classifies four soil groups, termed A, B, C, and D. The four soil groups represent the following runoff characteristics:

- Soil Group A — Soils (sands and gravels) with high transmissivity, therefore having a high infiltration rate, and low runoff potential (A=1)
- Soil Group B — Usually a mixture of fine and coarse textured soils with moderate transmissivity (and infiltration rates), therefore they have a low to moderated runoff potential (B=2)

- Soil Group C — Fine texture soils with low transmissivity rates and slow infiltration rates, which leads to moderate to high runoff potential (C=3)
- Soil Group D — Semi-pervious to impervious soils (i.e. clay) that have high runoff potential (D=4)

If a non-integer value is entered for the soil type at an element, IWFM rounds it to the nearest integer and uses it as the soil group number for the element. The drainage node related to each element routes the runoff from an element to a stream node. Several elements can drain to a single stream node. Drainage is highly dependent on the topography of the study area. If a value of zero is entered for drainage node then it is assumed that the surface flow leaves the modeled area.

Unit 13 also denotes the subregion and sub-group each element is associated with. Subregions and sub-groups contain multiple elements and are predominantly defined for reporting purposes. Much of the post-processing is tabulated by subregion.

The following list defines the input variables specified in Unit 13:

IE	Element number
IRNE	Rainfall station assigned to element IE
FRNE	Factor to convert rainfall at rainfall station IRNE to rainfall at element IE
ISTE	Stream node that the surface runoff from element IE drains to (enter zero if surface flow from element IE leaves the modeled area)
IRGE	Subregion number corresponding to element IE

ISGE	Sub-element group corresponding to element IE
ISOILE	Hydrologic soil information of element IE

```
C*******************************************************************************
C
C                    INTEGRATED WATER FLOW MODEL (IWFM)
C                          *** Version ### ***
C
C*******************************************************************************
C
C                     ELEMENT CHARACTERISTICS DATA FILE
C                         for IWFM Pre-Processing
C                                (Unit 13)
C
C
C             Project:  IWFM Version ### Release
C                       California Department of Water Resources
C             Filename: ELEMCHRC.DAT
C
C*******************************************************************************
C                             File Description
C
C   This data file contains the hydrologic characteristics of each element
C   including the rainfall station to be used, a rainfall factor  to relate
C   rainfall at the element to the rainfall station, stream node where
C   runoff drains to, the sub-region corresponding to the element, and the
C   hydrologic soil type.
C
C*******************************************************************************
C                          Element Characteristics Data
C
C   The following lists the hydrologic characteristics of each element:
C
C   IE;      Element number
C   IRNE;    Rainfall station assigned to the element IE
C             (enter zero for all elementsif no land processes other than
C              streams and lakes are modeled)
C   FRNE;    Factor to convert rainfall at the assigned rainfall station to
C            rainfall at the element IE
C   ISTE;    Stream node to which surface water from element IE drains to
C             (enter zero if the surface flow from element IE leaves the model area)
C   IRGE;    Subregion number to which element IE belongs to
C   ISGE;    Element sub-group number to which element IE belongs to
C   ISOILE;  Hydrologic soil property of the element (ie. A=1, B=2, C=3, D=4)
C            (Reference for A-D soil types: USDA, 1985)
C
C-------------------------------------------------------------------------------
C   Element    Rainfall   Rainfall    Drainage   Subregion  Element   Soil
C              station     factor       node                sub-grp   type
C     IE        IRNE        FRNE        ISTE       IRGE      ISGE    ISOILE
C-------------------------------------------------------------------------------
      1          1          1.0         18            1         2      1
      2          1          1.0         18            1         2      1
      3          1          1.0         18            1         2      1
      4          1          1.0         18            1         2      1
      5          1          1.0         18            1         2      1
      .          .          .           .             .         .      .
      .          .          .           .             .         .      .
      .          .          .           .             .         .      .
    396          2          1.0         6             2         1      1
    397          2          1.0         6             2         1      1
    398          2          1.0         6             2         1      1
    399          2          1.0         6             2         1      1
    400          2          1.0         6             2         1      1
```

2.3. Output Files

Binary Output File Unit 4

The binary file contains the pre-processing information used in the simulation portion of IWFM. The file is generated in the pre-processor program, and must be copied to the folder with the IWFM simulation executable program.

ASCII Output File Unit 6

The ASCII output file provides the user with information that was processed in the pre-processor portion of IWFM. The following list indicates the information available in this output file:

- Project title (specified in Unit 5)
- Date and time of run, which is determined internally within the program
- List of input files read in the pre-processing program
- Various warning and/or error messages
- Subregional areas
- Number of nodes, triangular elements, quadrilateral elements and groundwater layers
- Nodal x-y coordinates and areas associated with each node
- Elements, corresponding nodes, and elemental areas
- Top and bottom elevations of aquifer layers
- IUD variable at a node of an aquifer layer

IUD = 1 : the node is active; i.e. the aquifer layer exists at the particular node

IUD = –99 : the node is inactive; i.e. the aquifer layer thickness is zero and the layer does not exist at the particular node

- Stream reach information
- Well characteristics
- Number of active layers at each node
- Node numbers surrounding each groundwater node
- Non-zero components of conductance matrix

```
*****************************************************************************************************************************
                                                    IWFM
                                              Version 2.3 Release
                                                    DWR
*****************************************************************************************************************************

THIS RUN IS MADE ON 09/15/2005 AT 15:07:39

THE FOLLOWING FILES ARE USED IN THIS SIMULATION:
   4  OUTPUT1.BIN                                          09/15/2005  02:05
   5  MAIN.IN1                                             09/15/2005  02:15
   6  OUTPUT1.OUT
   7  ELEMENT.DAT                                          09/15/2005  02:14
   8  XY.DAT                                               09/15/2005  02:16
   9  STRATA.DAT                                           09/15/2005  02:15
  10  STREAM.DAT                                           09/15/2005  02:16
  11  LAKE.DAT                                             09/15/2005  02:15
  12
  13  ELEMCHRC.DAT                                         09/15/2005  02:14

REGION =   1    18365.60  ACRES
REGION =   2    18365.60  ACRES
      TOTAL     36731.20  ACRES

NO. OF NODES                          ( ND):       441
NO. OF TRIANGULAR ELEMENTS            (NET):         0
NO. OF QUADRILATERAL ELEMENTS         (NEQ):       400
NO. OF TOTAL ELEMENTS                 ( NE):       400
NO. OF LAYERS                         ( NL):         2
SUM OF CONNECTING NODES FOR EACH NODE ( NJ):      9335


 NODE             X             Y      AREA(ACRES)
    1          0.00          0.00         22.96
    .             .             .             .
    .             .             .             .
    .             .             .             .
  441      40000.00      40000.00         22.96


 ELEMENT          NODE         AREA(ACRES)
     1      1    2   23   22        91.83
     .      .    .    .    .           .
     .      .    .    .    .           .
     .      .    .    .    .           .
   400    419  420  441  440        91.83


    *** TOP AND BOTTOM ELEVATIONS OF AQUIFER LAYERS (FEET) ***
  NODE  GRND.SURF.          LAYER  1                    LAYER  2
                    IUD         TOP      BOTTOM    IUD        TOP     BOTTOM
     1      500.00    1      500.00        0.00      1     -10.00    -110.00
     .           .    .           .           .      .          .          .
     .           .    .           .           .      .          .          .
     .           .    .           .           .      .          .          .
   441      500.00    1      500.00        0.00      1       0.00    -100.00


REACH STREAM GRID     GROUND   INVERT            AQUIFER   ALLUVIAL    REGION     UPSTREAM   DOWNSTREAM   UPSTREAM
  NO.   NO.   NO.     ELEV.     ELEV.     DEPTH    BOTTOM  THICKNESS     NO.         ID          ID         NODES
                          (ALL UNITS ARE IN FEET)
     1     1   433     500.0     300.0     200.0       0.0     300.0         2          2          0
     1     2   412     500.0     298.0     202.0       0.0     298.0         2          0          0          1
     .     .     .         .         .         .         .         .         .          .          .          .
     .     .     .         .         .         .         .         .         .          .          .          .
     .     .     .         .         .         .         .         .         .          .          .          .
     3    22    34     500.0     262.0     238.0       0.0     262.0         1          0          0         21
     3    23    13     500.0     260.0     240.0       0.0     260.0         1          0          1         22


***** THERE ARE NO WELLS *****


 NODE   # OF LAYERS   TOP NODE   SURROUNDING GW NODES
    1             2          1      2   23   22
    .             .          .      .    .    .    .    .
    .             .          .      .    .    .    .    .
    .             .          .      .    .    .    .    .
  441             2        441    440  419  420


 ELEMENT               ELEMENT MATRIX COMPONENTS
     1         -0.17     -0.33     -0.17     -0.17     -0.33     -0.17
     .             .         .         .         .         .         .
     .             .         .         .         .         .         .
     .             .         .         .         .         .         .
   400         -0.17     -0.33     -0.17     -0.17     -0.33     -0.17
************************************************
TOTAL RUN TIME:    0 MINUTES  0.12 SECONDS
************************************************
```

3. Simulation

The simulation portion of IWFM models the groundwater flow and related processes within the project domain for a simulation time period. This chapter details the structure of the simulation program and the input and output files associated with this portion of the program.

3.1. Subroutine Descriptions

The simulation program is a procedural FORTRAN program, and consists of a main program which calls several subroutines that simulate groundwater flow and other related hydrologic processes (Figure 3.1). This section describes each subroutine.

Iwfm_f2 This is the main subroutine that controls the simulation process and calls the subroutines listed below.

Readcd This subroutine reads the main input data.

Array_allocate This subroutine reads in data from input data files and allocates array dimensions.

Getgd This subroutine reads the information stored in the binary file generated during the execution of Pre-processor, reads

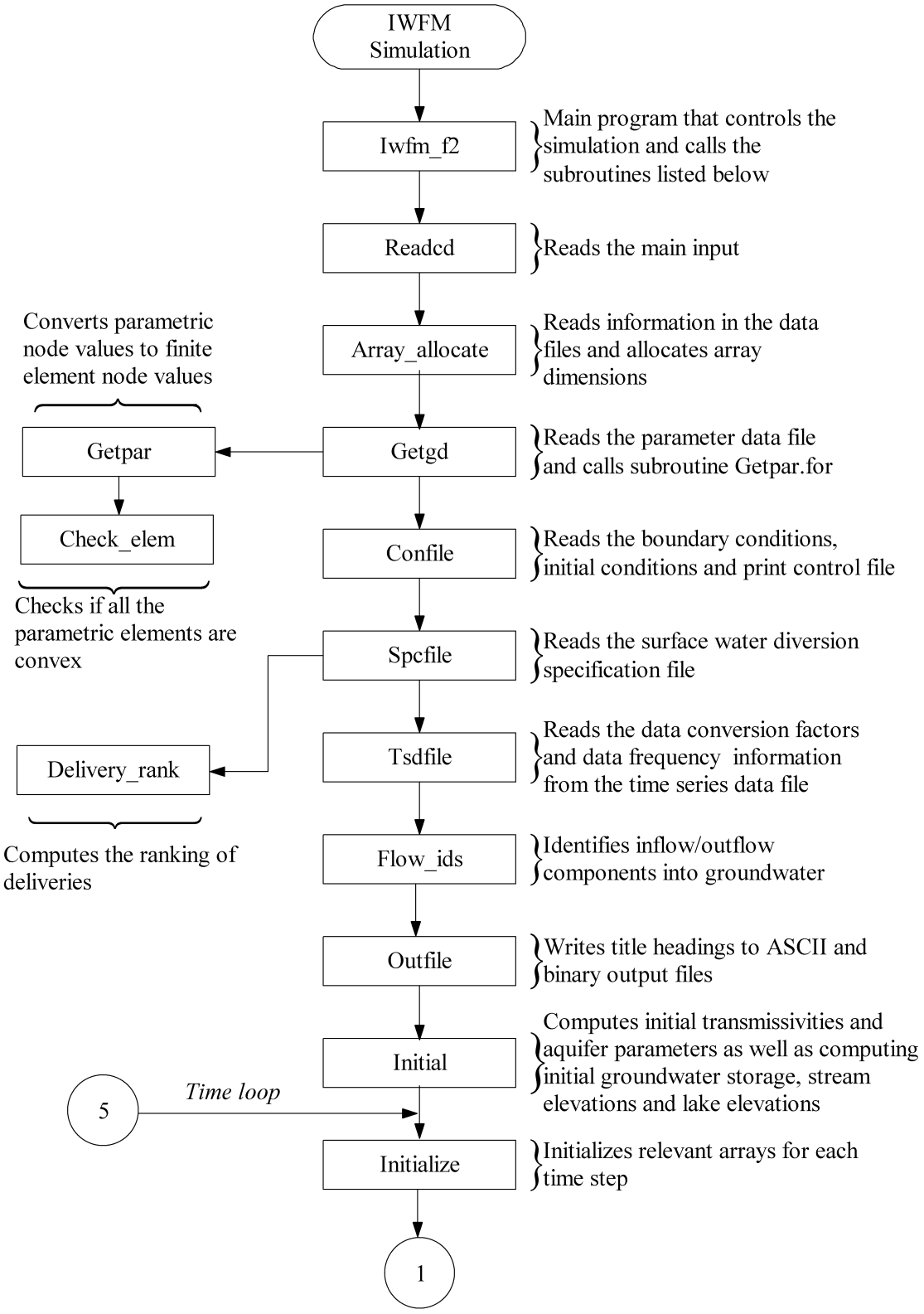


Figure 3.1 IWFM Simulation subroutines

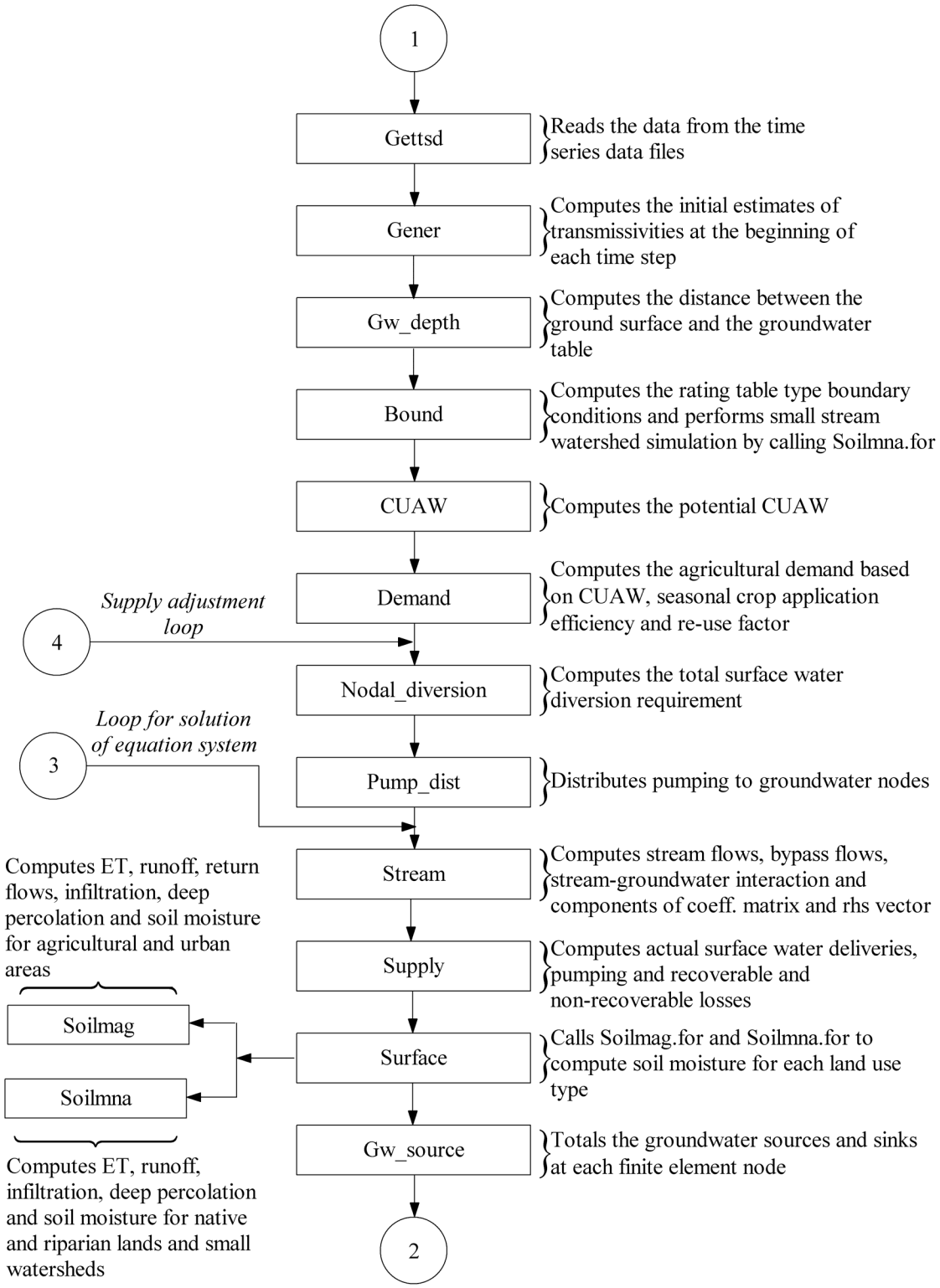


Figure 3.1 IWFM Simulation subroutines *(continued)*

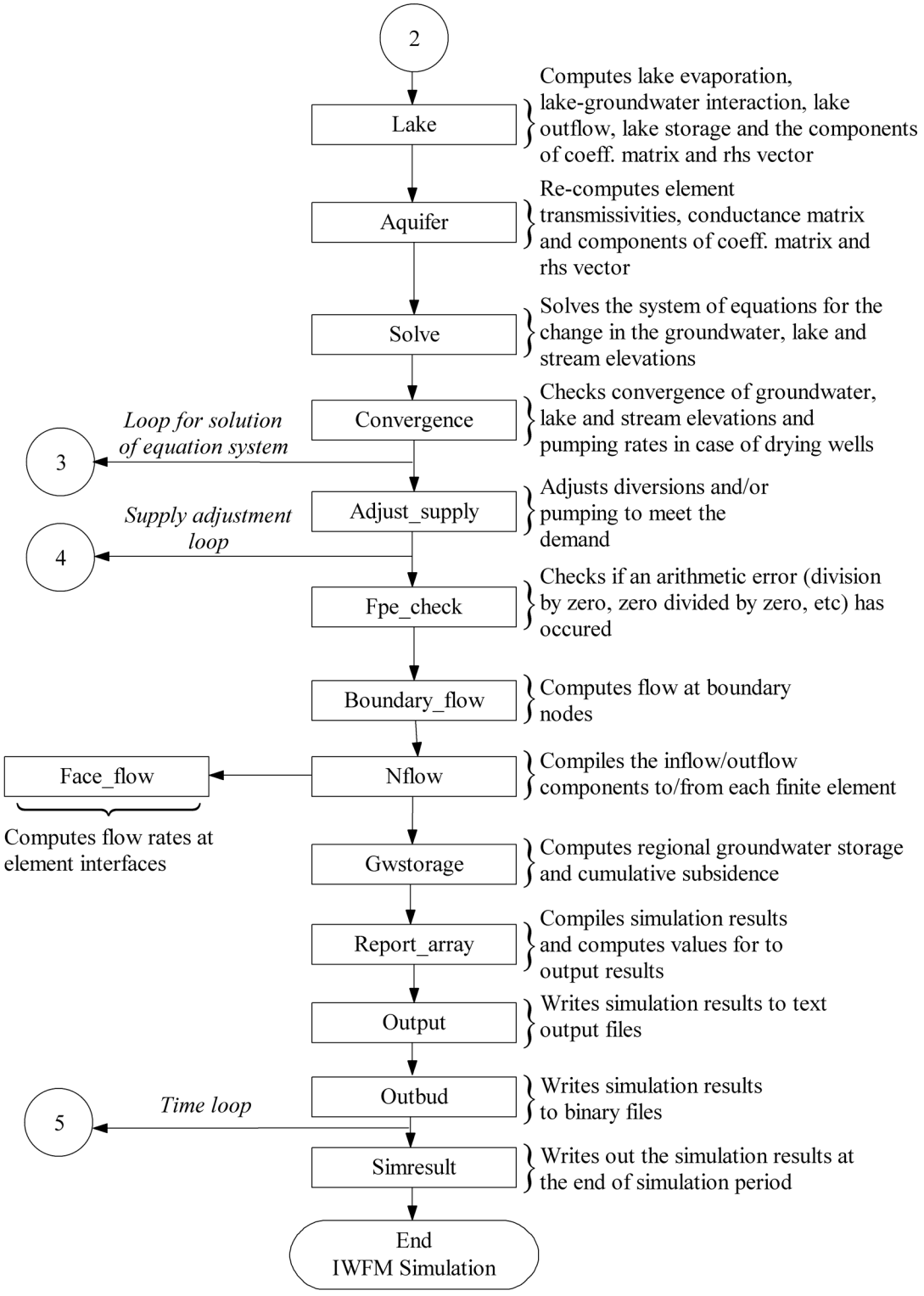


Figure 3.1 IWFM Simulation subroutines *(continued)*

in parameter data file and calls subroutine Getpar to convert parametric grid information to correspond to the finite element mesh of the project domain.

Getpar Converts parametric node values to finite element node values.

Check_elem This subroutine checks that all the parametric elements specified in the parameter file are convex, i.e. the internal angles at the nodes of an element are all less than 180 degrees.

Confile This subroutine reads the following input data files: boundary conditions, print control file and initial conditions.

Spcfile This subroutine reads the surface water diversion specification file and finds the ranking of the deliveries to be used for the surface water diversions adjustment feature by calling the subroutine Delivery_rank.

Delivery_rank Computes the ranking of the deliveries to be used for the surface water diversions adjustment feature.

Tsdfile This subroutine reads in the data conversion factors and data frequency information from each of the time series input file.

Flow_ids This subroutine identifies the different sources of inflow/outflow components to/from the aquifer system based on the hydrologic processes included in the simulation. This information is used when detailed inflow/outflow components are printed for each sub-domain by the Z-Budget post-processor.

Outfile This subroutine writes title headings to ASCII and binary simulation output files.

Initial This subroutine computes the initial transmissivities, storativities, vertical leakances and pre-compaction head values for groundwater nodes within the model domain. It also computes regional groundwater storage, soil moisture content in the unsaturated zone. Finally, it sets the initial stream elevations and computes lake storages.

Initialize This subroutine initializes relevant arrays for each time step.

Gettsd This subroutine reads the following time series data files: subregional crop and non-agricultural land use areas, elemental land use areas, pumping specifications and time-series pumping data, surface water diversions, irrigation fractions, supply adjustment specifications, stream flows, precipitation, evapotranspiration, agricultural demand or agricultural demand parameters, urban water use specifications, urban water demand and time series boundary conditions data.

Gener This subroutine computes the initial estimate of transmissivities at the beginning of each time step except the first time step. The initial estimates of transmissivities for the first time step is computed in Initial.

Gw_depth This subroutine computes the distance between the ground surface and the groundwater table.

Bound This subroutine computes the rating table type boundary condition and performs the small stream watershed simulation in conjunction with Soilmna.

CUAW This subroutine computes the potential consumptive use of applied water based on the available soil moisture, precipitation, crop evapotranspiration and minimum soil moisture requirement.

Demand This subroutine computes the agricultural water demand based on the potential consumptive use of applied water, seasonal crop application efficiency and re-use factor.

Nodal_diversion This subroutine computes the total surface water diversion requirement at each stream node based on the surface water diversion specifications and diversion data.

Pump_dist Depending on the type of pumping data entered (well pumping or elemental pumping) this subroutine either distributes pumping from well locations to surrounding nodes or pumping from elements to corresponding nodes.

Stream This subroutine computes stream flows, bypass flows, actual diversion amounts, diversion shortgaes and stream-groundwater interaction based on the estimate of the stream surface elevations. It also computes the relevant components of the coefficient matrix and the right-hand-

side vector that are used in the solution of the system of non-linear equations.

Supply This subroutine computes the actual surface water deliveries to urban and agricultural areas, recoverable losses and non-recoverable losses from surface water diversion and bypass processes as well as the amount of pumping from groundwater that is delivered to agricultural and urban lands.

Surface This subroutine includes subregional soil moisture computations for the root zone and elemental soil moisture computations for the unsaturated zone. Soil moisture computations differ slightly for native and riparian lands than agricultural and urban lands because of the computations due to the application of water to agricultural and urban lands. Therefore, subroutine Soilmag is called to perform soil moisture computations of the agricultural and urban areas whereas Soilmna is called to compute soil moisture in native and riparian areas.

Soilmag This subroutine computes ET, runoff, return flows, infiltration, deep percolation and soil moisture in agricultural and urban lands within the modeled area.

Soilmna This subroutine computes ET, runoff, infiltration, deep percolation and soil moisture in areas with native and riparian vegetation, as well as small stream watersheds used as boundary conditions.

Gw_source This subroutine totals the groundwater sources and sinks at each finite element node.

Lake This subroutine computes lake evaporation, lake-groundwater interaction, lake overflow and lake storage based on the estimate of the lake surface elevation. It also computes the relevant components of the coefficient matrix and the right-hand-side vector that are used in the solution of the system of non-linear equations.

Aquifer This subroutine re-computes the element transmissivities, and the conductance matrix. It also computes the relevant components of the coefficient matrix and the right-hand-side vector that are used in the solution of the system of non-linear equations.

Solve This subroutine solves the system of equations using the coefficient matrix and the right-hand-side vector whose

components are computed in Stream, Lake and Aquifer. The solution of the system of equations results in the changes in the estimated groundwater, stream and lake elevations.

Convergence This subroutine checks if the changes in the estimated groundwater, stream and lake elevations computed in Solve are smaller than a user-specified tolerance. It also checks if the aquifer at any node dries up due to pumping during the time step. If so, pumping rates are readjusted for the computation of the actual amount of water that is pumped from a drying well.

Adjust_supply This subroutine adjusts, per user's request, the stream diversions and/or groundwater pumping to minimize the discrepancy between the agricultural and urban water demand and the water supply.

Fpe_check This subroutine checks if an arithmetic operation that causes a floating point error (division by zero, zero divided by zero, etc.) has occurred during simulation. If such an operation is detected at a time step the simulation results

from previous time step are printed out to file Unit 50 and the simulation is aborted.

Boundary_flow This subroutine computes the flow rates at the boundary nodes.

Nflow This subroutine compiles the inflow/outflow terms for each finite element at each aquifer layer and calls the Face_flow subroutine to compute the flow rates at each element interface. This subroutine also prints out the results, i.e. detailed inflow/outflow terms for each element, to the binary file which is later used by Z-Budget post-processor to compute water budgets for sub-domains.

Face_flow This subroutine locally solves the set of equations to compute the element face flows.

Gwstorage This subroutine computes the regional groundwater storage at the end of the time step and the cumulative subsidence.

Report_arrays This subroutine compiles the simulation results and computes the array values that are used in the reporting of the results.

Output This subroutine writes the simulation results to the ASCII output files.

Outbud This subroutine writes the simulation information to binary files that can be used to produce budget tables by running the IWFM budget post-processing program.

Simresult This subroutine writes out the simulation results at the end of the simulation period to an ASCII output file in the same format as the initial conditions input data file.

3.2. Input Files

This section consists of input file explanations, the description of variables in each simulation input file and a sample of each input file. The user should not judge input file spacing based on the sample input files provided in this documentation, instead refer to the input files from a copy of the most recent version of IWFM.

In setting the spatial and temporal input data to be used in IWFM runs, the user is free to specify data with any units as long as the correct conversion factors are specified. IWFM does not use a particular set of units internally. Instead, the user decides on the units to be used and it is the user's responsibility to specify appropriate conversion factors in the input data files to convert a particular data unit to the unit used during

simulation. Preparation of each data file includes the entry of relevant conversion factors that need to be specified by the user.

All time series data files require specifying the NSP_ and NFQ_ variables. For instance, in the stream inflow data file (Unit 21) these variables appear as NSPSTRM and NFQSTRM, respectively. These variables are included in time-series data files in order to make the entry of repetitive data more convenient. NSP_ variable is the number of time steps before a particular time-series data is updated. NFQ_ variable is the repetition frequency of the particular data file. As an example, consider monthly evapotranspiration data. In practice, potential evapotranspiration rates change from month to month but they stay the same from one year to another. Therefore, generally one value of ET rate is defined for each month of the year and these values are used for the corresponding months of all simulation years. The repetitive evapotranspiration data entry can be avoided by the use of NSP_ and NFQ_ variables. If IWFM is run on a monthly time step, then NSPET in evapotranspiration data file (Unit 16) can be set as 1, NFQET as 12 and the 12 monthly evapotranspiration rates can be listed afterwards with the first ET data corresponding to the first simulation month. This means that IWFM will read an ET value at the beginning of every time step (NSPET = 1) and when it reads in 12 values (NFQET = 12) it will rewind the data file and start reading ET values from the beginning of the file.

As another example, consider using the same monthly ET data with a daily IWFM run. Assuming that there are 30 days in each month (IWFM does not make such assumptions internally. It is up to the user to make and defend such assumptions) the same 12-value ET data can be used buy setting NSPET to 30 and NFQET to 12. This

time IWFM will read an ET value and use it for 30 time steps (NSPET = 30), i.e. 30 days. At the beginning of the 31st time step, i.e. 31st day, it will read in the next ET value and use it for another 30 time steps. When a total of 12 readings from Unit 16 is made (NFQET = 12), IWFM will rewind the data file and continue reading values from the start of the file. If, on the other hand, the full time series data for the entire simulation period is supplied then NFQ_ variable should be set to zero.

The following sections give detailed descriptions of each input and output data file involved in simulation part of IWFM.

Main Simulation Input File Unit 5

The main input file for IWFM simulation is similar to the pre-processor main input file, in that it contains the file names for all data files, output files, and binary files as well as unit output specifications. The character 'c', 'C', or '*', in the first column indicates a comment line in the data file. These characters can not be placed in the first column to be read as input. The title of the model run is specified in this file and is printed in the ASCII output file. The program accepts a maximum of three title lines. The input and output file names and descriptions are included in this file. The time step length, unit of time step and the total simulation length are also specified.

Three output and debugging options are available in IWFM. A value of 2 directs the program to print program execution to the screen. A value of 1 prints aquifer parameter data to the main text output file (Unit 6). Printing the aquifer parameter data is

useful during model calibration. Above options can be turned off by specifying KDEB as zero.

Some simulation results can be written to text output files. The information in the output files is displayed based on the unit conversion factors and unit names specified in this input file. The output unit control parameters are used to display the output files in the units specified by the user.

Solution scheme control parameters (namely the solution method, the relaxation parameter, maximum number of iterations and convergence criteria for the solution of equation system, non-linear soil moisture and the supply adjustment) are also specified in this file. The user can choose between two matrix inversion methods, namely the successive overrelaxation (SOR) and the generalized preconditioned conjugate (GMRES) methods. If SOR method is used then the overrelaxation parameter should be set to a value between 1.0 and 2.0. For GMRES method this parameter is not used even though some value has to be entered to avoid immature stopping of the Simulation program. In the situation that the solution of the system of equations or the non-linear conservation equation for soil moisture does not satisfy the specified convergence criteria within the maximum number of iterations set, the user should re-evaluate the convergence criteria and/or maximum number of iterations set. The convergence criteria and the maximum iteration number for the supply adjustment are used if automated supply adjustment is turned on.

The agricultural supply requirement can be specified as input in Unit 19 or obtained based on the potential CUAW computed in IWFM and the efficiencies provided in Unit 22. KOPTDM is specified as zero when the agricultural supply requirement is

specified in Unit 19, whereas a value of 1 indicates the agricultural supply requirement is computed based on the values read from input file Unit 22. The functionality of adjusting surface water diversions and/or pumping internally can be activating by setting KOPTDV to a value other than 00.

The output time period and frequency for Unit 48 output is specified in this file. Unit 48 provides nodal groundwater head values for the time period at the frequency specified in this input file. The elements within the model domain are grouped into subregions for modeling and accounting purposes. The number of subregions is specified in this file. The following is a list of the variables used in this data file:

DELTAT	Time step used in the simulation of hydrologic processes. At this point, this value is hard coded as 1.0
UNITT	Unit of time step DELTAT (maximum of 8 character)
NTIME	Total number of time steps in the simulation
KDEB	Switch for output and debugging options (2 = print messages on the screen to monitor execution; 1 = print aquifer parameter data to the standard output file; 0 = turn off output and debugging options)
FACTLTOU	Factor to convert simulation unit of length to output unit of length
UNITLTOU	Output unit of length (maximum 10 characters long)
FACTAROU	Factor to convert simulation unit of area to output unit of area
UNITAROU	Output unit of area (maximum 10 characters long)
FACTVLOU	Factor to convert simulation unit of volume to output unit of volume
UNITVLOU	Output unit of volume (maximum 10 characters long)

FACTVROU	Factor to convert simulation unit of volumetric flow rate into intended output unit of volumetric flow rate
UNITVROU	Output unit of volumetric flow rate (maximum 10 characters long)
MSOLVE	Matrix solution method. Enter 1 to use the successive overrelaxation (SOR) method, or enter 2 to use the generalized preconditioned conjugate method
RELAX	Relaxation parameter for the successive overrelaxation method used in solving the system of equations (value should be between 1.0 and 2.0)
MXITER	Maximum number of iterations for the solution of system of equations
MXITERSM	Maximum number of iterations for the nonlinear soil moisture accounting
MXITERSP	Maximum number of iterations for supply adjustment
STOPC	Convergence criteria for groundwater, stream and lake head difference, [L]
STOPCSM	Convergence criteria for soil moisture, [L]
STOPCSP	Fraction of water demand to be used as a convergence criteria for iterative supply adjustment. If the difference between the water supply and water demand at agricultural and/or urban lands in a subregion is less than the convergence criteria, then supply adjustment is skipped.

KOPTDM	Option to specify the agricultural supply requirement: A value of 0 directs the program to read the agricultural supply requirement from Unit 19. A value of 1 specifies the agricultural supply requirement to be computed in IWFM based on the computed potential CUAW and efficiencies read in Unit 22.
KOPTDV	Switch to turn on/off the automated water supply adjustment functionality of IWFM. It is specified as a two digit number. First digit from left turns on/off adjustment of groundwater pumping (0 = no adjustment; 1 = adjust groundwater pumping). Second digit from left turns on/off the adjustment of surface water diversions (0 = no adjustment for diversions; 1 = adjust diversions so that diversions meet the total water demand less the groundwater pumping; 2 = adjust diversions so that diversions meet the total water demand). If both diversions and pumping are specified to be adjusted, then diversions are adjusted first and pumping is adjusted second. It should be noted that options 11 and 12 result in identical adjusted diversion and pumping values. If KOPTDV is set to a value other than 00, then file Unit 12 (supply adjustment specification file) should also be supplied.
NCROP	Number of agricultural crops modeled (a value of at least 1 should be entered)
MPRNTS	Time step for the start of printing head values in Unit 48
MPRNTL	Time step for the end of printing head values in Unit 48

NFQPRNT	Frequency of head value output to Unit 48
NREGN	Number of subregions modeled

```
C*******************************************************************************
C
C                    INTEGRATED WATER FLOW MODEL (IWFM)
C                          *** Version ### ***
C
C*******************************************************************************
C
C                            MAIN INPUT FILE
C                           for IWFM Simulation
C                                (Unit 5)
C
C
C             Project:  IWFM Version ### Release
C                       California Department of Water Resources
C             Filename: MAIN.IN2
C
C*******************************************************************************
C                              File Description
C
C    This file contains the title of the run to be printed in the output,
C    the names and descriptions of all simulation input files, conversion
C    factors and output control options for running the simulation model.
C
C*******************************************************************************
C                         Titles Printed in the Output
C
C   *A maximum of 3 title lines can be printed.
C   *Do not use '*' , 'c' or 'C' in the first column of the title lines.
C
C                           **********************
                                  IWFM
                             Version ### Release
                                   DWR
C                           **********************
C*******************************************************************************
C                              File Description
C
C  *Listed below are all input and output file names used when running the
C   IWFM simulation.
C
C  *Each file name has a maximum length of 50 characters
C
C  *If a file does not exist for a project, leave the filename blank
C   For example, if tile drains are not modeled in the project, the file name and
C   description columns for unit 17 will appear as:
C
C    FILE NAME                                          DESCRIPTION
C                                                       /17: TILE DRAINS PARAMETER DATA FILE
C-------------------------------------------------------------------------------
C    FILE NAME                                          DESCRIPTION
C-------------------------------------------------------------------------------------------------
                                                        / 2: ***(Not used in this version)***
                                                        / 3: ***(Not used in this version)***
   OUTPUT1.BIN                                          / 4: BINARY INPUT GENERATED BY PRE-PROCESSOR (INPUT, REQUIRED)
   MAIN.IN2                                             / 5: CONTROL INPUT FILE (INPUT, REQUIRED)
   OUTPUT2.OUT                                          / 6: STANDARD OUTPUT FILE (OUTPUT, REQUIRED)
   PARAMETER.DAT                                        / 7: PARAMETER DATA FILE (INPUT, REQUIRED)
   BOUND.DAT                                            / 8: BOUNDARY CONDITION DATA FILE (INPUT, REQUIRED)
   BOUNDTSD.DAT                                         / 9: TIME SERIES BOUNDARY CONDITIONS (INPUT, OPTIONAL)
   PRINT.DAT                                            /10: PRINT CONTROL FILE (INPUT, OPTIONAL)
   INIT.DAT                                             /11: INITIAL CONDITION DATA FILE (INPUT, REQUIRED)
   SUPADJ.DAT                                           /12: SUPPLY ADJUSTMENT SPECIFICATION DATA FILE (INPUT, OPTIONAL)
   LANDUSE.DAT                                          /13: LAND USE DATA FILE (INPUT, OPTIONAL)
   CROPAREA.DAT                                         /14: CROP ACREAGE DATA FILE (INPUT, OPTIONAL)
   PRECIP.DAT                                           /15: PRECIPITATION DATA FILE (INPUT, OPTIONAL)
   ET.DAT                                               /16: EVAPOTRANSPIRATION DATA FILE (INPUT, OPTIONAL)
   TILEDRN.DAT                                          /17: TILE DRAINS PARAMETER DATA FILE (INPUT, OPTIONAL)
   URBSPEC.DAT                                          /18: URBAN WATER USE SPECIFICATION DATA FILE (INPUT, OPTIONAL)
                                                        /19: AGRICULTURAL WATER SUPPLY REQUIREMENT DATA (INPUT, OPTIONAL)
   URBDEMAND.DAT                                        /20: URBAN WATER DEMAND FILE (INPUT, OPTIONAL)
   INFLOW.DAT                                           /21: STREAM INFLOW DATA FILE (INPUT, OPTIONAL)
   CROPDEMAND.DAT                                       /22: CROP DEMAND PARAMETER DATA (Req'd for CUAW est.) (INPUT, OPTION
   PUMPSPEC.DAT                                         /23: PUMPING SPECIFICATION DATA FILE (INPUT, OPTIONAL)
   PUMP.DAT                                             /24: PUMPING DATA FILE (INPUT, OPTIONAL)
   DIVERSPEC.DAT                                        /25: SURFACE WATER DIVERSION SPECIFICATION FILE (INPUT, OPTIONAL)
   DIVER.DAT                                            /26: SURFACE WATER DIVERSION DATA FILE (INPUT, OPTIONAL)
   IRIGFRAC.DAT                                         /27: IRRIGATION FRACTION DATA FILE (INPUT, OPTIONAL)
   MAXLKELEV.DAT                                        /28: MAXIMUM LAKE ELEVATIONS DATA FILE (INPUT, OPTIONAL)
   RUF.DAT                                              /29: IRRIGATION WATER RE-USE FACTOR DATA FILE (INPUT, OPTIONAL)
   OVERWRITE.DAT                                        /30: AQUIFER PARAMETER OVER-WRITE DATA FILE (INPUT, OPTIONAL)
   ZBUDGET.BIN                                          /31: BINARY OUTPUT FOR GROUNDWATER ZONE BUDGET (OUTPUT,OPTIONAL)
   SMWSHED.BIN                                          /32: BINARY OUTPUT FOR SMALL WATERSHED FLOW COMPONENTS (OUTPUT, OPTI
   SUBGRP.BIN                                           /33: BINARY OUTPUT FOR ELEMENT SUB-GROUP DETAILS (OUTPUT, OPTIONAL)
   DIVERDTL.BIN                                         /34: BINARY OUTPUT FOR DIVERSION DETAILS (OUTPUT, OPTIONAL)
   REACH.BIN                                            /35: BINARY OUTPUT FOR STREAM BUDGET BY REACH (OUTPUT, OPTIONAL)
   LAKE.BIN                                             /36: BINARY OUTPUT FOR LAKE BUDGET (OUTPUT, OPTIONAL)
   LWU.BIN                                              /37: BINARY OUTPUT FOR LAND AND WATER USE BUDGET (OUTPUT, OPTIONAL)
   STRM.BIN                                             /38: BINARY OUTPUT FOR STREAM BUDGET (OUTPUT, OPTIONAL)
   SOIL.BIN                                             /39: BINARY OUTPUT FOR ROOT ZONE MOISTURE BUDGET    (OUTPUT, OPTIONA
   GW.BIN                                               /40: BINARY OUTPUT FOR GROUNDWATER BUDGET (OUTPUT, OPTIONAL)
```

```
                                                /41: ***(Not used in this version)***
                                                /42: ***(Not used in this version)***
   FACEFLOW.OUT                                 /43: ELEMENT FACE FLOW OUTPUT FILE (OUTPUT, OPTIONAL)
   BNDFLX.OUT                                   /44: BOUNDARY FLUX OUTPUT FILE (OUTPUT, OPTIONAL)
   TDRN.OUT                                     /45: TILE DRAIN/SUBSURFACE IRRIGATION HYDROGRAPH OUTPUT FILE (OUTPUT
   STRM.HYD                                     /46: STREAM FLOW HYDROGRAPH OUTPUT FILE (OUTPUT, OPTIONAL)
   GW.HYD                                       /47: GW LEVEL HYDROGRAPH OUTPUT FILE (OUTPUT, OPTIONAL)
   GWHEAD.HYD                                   /48: GW LEVEL OUTPUT AT EVERY MODEL NODE (OUTPUT, OPTIONAL)
   VERTFLOW.OUT                                 /49: LAYER VERTICAL FLOW OUTPUT (OUTPUT, OPTIONAL)
   FNRESULTS.OUT                                /50: FINAL SIMULATION RESULTS (OUTPUT, REQUIRED)
C*******************************************************************************
C                         Model Simulation Period
C
C   The following lists the simulation time step and simulation period.
C
C   DELTAT; Time step to be used in the simulation of hydrologic processes
C           *** (Note: DELTAT is hard-coded to be 1.0 in this version) ***
C   UNITT ; Unit of time step DELTAT (maximum 8 characters)
C   NTIME ; Number of time steps in the simulation
C
C-------------------------------------------------------------------------------
C       VALUE                   DESCRIPTION
C-------------------------------------------------------------------------------
        1.0                     / DELTAT
        DAYS                    / UNITT
        3600                    / NTIME
C*******************************************************************************
C                         Output and Debugging Options
C
C   The following lists the options for detailed output and debugging.
C   KDEB;    Enter 2 - to print messages on the screen to monitor execution
C            Enter 1 - to print aquifer parameter data
C            Enter 0 - otherwise
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
    0                           / KDEB
C*******************************************************************************
C                    Output Unit Control
C
C    FACTLTOU; Factor to convert simulation unit of length into intented output unit of length
C    UNITLTOU; Output unit of length (max. 10 characters long)
C    FACTAROU; Factor to convert simulation unit of area into intended output unit of area
C    UNITAROU; Output unit of area (max. 10 characters long)
C    FACTVLOU; Factor to convert simulation unit of volume into intended output unit of volume
C    UNITVLOU; Output unit of volume (max. 10 characters long)
C    FACTVROU; Factor to convert simulation unit of volumetric flow rate into intended output
C               unit of volumetric flow rate
C    UNITVROU; Output unit of volumetric flow rate (max. 10 characters long)
C
C-------------------------------------------------------------------------------
C VALUE                         DESCRIPTION
C-------------------------------------------------------------------------------
    1.0                         / FACTLTOU
    FEET                        / UNITLTOU
    0.000022957                 / FACTAROU
    ACRES                       / UNITAROU
    0.000022957                 / FACTVLOU
    ACRE-FEET                   / UNITVLOU
    0.000022957                 / FACTVROU
    AC.FT.DAY                   / UNITVROU
C*******************************************************************************
C                           Solution Scheme Control
C
C   The following lists the solution scheme control parameters used in SIMULATION
C
C   MSOLVE  ; Matrix solution method
C               1 = SOR method
C               2 = Generalized preconditioned conjugate method
C   RELAX   ; Relaxation parameter for SOR (value should be between 1.0 and 2.0)
C   MXITER  ; Maximum number of iterations for the solution of system of equations
C   MXITERSM; Maximum number of iterations for the nonlinear soil moisture accounting
C   MXITERSP; Maximum number of iterations for supply adjustment
C   STOPC   ; Convergence criteria for groundwater, stream and lake head difference; [L]
C   STOPCSM ; Convergence criteria for soil moisture difference; [L]
C   STOPCSP ; Fraction of water demand to be used as convergence criteria for
C              iterative supply adjustment
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
     1                          / MSOLVE
     1.0                        / RELAX
     1500                       / MXITER
     150                        / MXITERSM
     50                         / MXITERSP
     0.0001                     / STOPC
     0.001                      / STOPCSM
     0.001                      / STOPCSP
C*******************************************************************************
C                    Water Budget Control Options
```

```
C
C   KOPTDM;  Enter  0 or 1 as follows;
C            0 = Agricultural water supply requirement is read in from file Unit 19;
C            1 = Agricultural demand is computed based on CUAW (i.e. AG. DEMAND=CUAW/I.E.)
C                In this case file unit 22 must be provided.
C   KOPTDV;  Enter two digits as follows:
C            1st digit(from left):
C                      0 = No adjustment for groundwater pumping
C                      1 = YES: Adjust groundwater pumping
C
C            2nd digit(from left):
C                      0 = No adjustment for streamflow diversion
C                      1 = YES: Surface Water Div. = Total Demand-Groundwater Pumping
C                      2 = YES: Surface Water Div. = Total Demand
C            ** Note: When this flag is set to a value other than 00, file Unit=12 is required.
C   NCROP;   Number of agricultural crops
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
      1                        / KOPTDM
      01                       / KOPTDV
      2                        / NCROP
C*******************************************************************************
C                   Output Control Options
C
C   MPRNTS;  Time step for the start of printing groundwater head values in Unit 48
C   MPRNTL;  Time step for the end of printing groundwater head values in Unit 48
C   NFQPRNT; Frequency of head value output to Unit 48
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
     1                          / MPRNTS
     3600                       / MPRNTL
     1                          / NFQPRNT
C*******************************************************************************
C                         Subregions
C
C   NREGN;  Number of subregions being modeled
C
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
      2                         / NREGN
```

Parameter File Unit 7

The parameter data file contains multiple data types that include parameters for all groundwater nodes and layers. Data may be by parametric grids, or node-by-node parametric values. Parameters are also set for the unsaturated zone, soil moisture, small stream watersheds, streambeds, lakes, and water use. The file is broken into the following sections:

Aquifer Parameters

Aquifer parameters can be specified using parametric grids (NGROUP>0) or for each groundwater node (NGROUP=0). The NGROUP value indicates the number of parametric grids used to define aquifer parameters. Regardless of the value specified for NGROUP, the following list specifies the variables that must be defined in Unit 7:

NGROUP	Number of parametric grid groups
FX	Conversion factor for parametric grid coordinates
FKH	Conversion factor for aquifer horizontal hydraulic conductivity
FS	Conversion factor for specific storage coefficient
FN	Factor to weight specific yield value
FV	Conversion factor for aquitard vertical hydraulic conductivity
FL	Conversion factor for aquifer vertical hydraulic conductivity
FSCE	Conversion factor for elastic storage coefficient
FSCI	Conversion factor for inelastic storage coefficient
FDC	Conversion factor for interbed thickness

FDCMIN	Conversion factor for minimum interbed thickness
FHC	Conversion factor for pre-compaction hydraulic head

From the parametric grid information, aquifer parameters at parametric nodes are interpolated to obtain parameter values at finite element nodes within the model domain. A parametric grid group may zoom in closer on groundwater nodes associated with the group and overwrite values given in the previous group. A value of −1 for any parameter specified for a node within a parametric grid group indicates that the parameter value specified in the previous group for the parametric node remains the same value. For NGROUP value greater than zero, the following information must be defined for each parametric grid group:

NDP	Number of parametric nodes in the parametric grid
NEP	Number of parametric elements in the parametric grid
IE	Parametric element number
NODE	Corresponding parametric node
ID	Parametric node number
PX, PY	Parametric node coordinates, [L]
PKH	Aquifer horizontal hydraulic conductivity, [L/T]
PS	Specific storage, [1/L]
PN	Specific yield, [L/L]
PV	Aquitard vertical hydraulic conductivity, [L/T]
PL	Aquifer vertical hydraulic conductivity, [L/T]
SCE	Elastic storage coefficient (Use SCE*DC if DC=0), [1/L]
SCI	Inelastic storage coefficient (Use SCI*DC if DC=0), [1/L]

DC Interbed thickness, [L]

DCMIN Minimum interbed thickness, [L]

HC Pre-compaction hydraulic head (set to 99999.0 to use the initial heads for the value of HC), [L]

The values of SCE, SCI, DC, DCMIN and HC are specified only for interbed layers.

In order to set parameters at specified finite element nodes to values defined at an individual parametric node, then the number of parametric nodes, NDP, should be given as 1 and number of parametric elements, NEP, should be given as 0. This is useful when a portion or the entire model domain is homogeneous, and parameters at specified finite element nodes are required to be set to the same values. If this feature is utilized (i.e. NDP is set to 1 and NEP is set to 0) then the construction of parametric elements needs to be skipped (i.e. specification of IE and NODE).

If no parametric grids are specified, advance to the point in the data file where aquifer parameters are specified by each groundwater node (Option 2). In this case, the above parameter values are specified for each finite element node. The conversion factors specified above are used to convert input data units to the units that are used in the simulation.

Anomaly in Hydraulic Conductivity

If there are hydraulic conductivity values defined in the previous section that need to be overwritten, the following parameters in this file must be defined:

NEBK	Number of elements where hydraulic conductivity values will be overwritten
FACT	Conversion factor for anomaly hydraulic conductivity values
IC	Identification number of the element for which anomaly hydraulic conductivity is defined
IEBK	Element number corresponding to counter IC
BK	Hydraulic conductivity at the specified element; this value should be given for each aquifer layer modeled in IWFM

Unsaturated Zone Parameters

This section is skipped if soil moisture in the unsaturated zone is not modeled, i.e. no rain gages are specified in the Pre-processor. Similar to aquifer parameters, the unsaturated zone parameters can be defined for each element, or by parametric grids. Regardless of how unsaturated zone parameters are defined, the number of layers, parametric groups and conversion factors must be specified:

NUNSAT	Number of layers in the unsaturated zone
NGROUP	Number of parametric groups that define the unsaturated zone parameters
FX	Conversion factor for parametric grid coordinates (it should be specified even if parametric grids are not being used and unsaturated zone parameters are specified for each element)
FD	Conversion factor for the thickness of the unsaturated layer
FN	Factor to weight unsaturated zone porosity

FL Conversion factor for the unsaturated zone hydraulic conductivity

If the option to use parametric grids is selected (Option 1), the following procedure occurs: the grid must first be defined by number of nodes and elements, then the makeup of the elements by nodes, and finally the specific characteristics of those nodes with respect to the unsaturated zone parameters:

NDP Number of nodes in the parametric grid

NEP Number of elements in the parametric grid

IE Parametric element number

NODE Corresponding parametric nodes (4 nodes should entered for each parametric element. For triangular elements 4^{th} node must be set to zero)

ID Parametric node number

PX x-coordinate of the parametric node, [L]

PY y-coordinate of the parametric node, [L]

PD Thickness of unsaturated layer (if thickness for the last unsaturated layer is entered as zero, the program will compute the thickness of the last unsaturated layer), [L]

PN Effective porosity of unsaturated zone, [L/L]

PL Hydraulic conductivity of unsaturated zone, [L/T]

If no parametric grids are specified, advance to the point in the data file where unsaturated zone parameters are specified by each element (Option 2). In this case, the above parameter values are specified for each finite element. The conversion factors

specified above are used to convert input data units to the units that are used in the simulation.

Parameters for Soil Moisture Routing

This section is skipped if the root zone is not modeled, i.e. if no rain gages are specified in the Pre-processor. The following root zone parameters are specified by subregion for the four soil types and land use types modeled:

FACT	Conversion factor for root zone hydraulic conductivity
IREGN	Subregion number
FC	Field capacity (it is converted to a unit of depth in IWFM by multiplying it with the root zone depth), [L/L]
EF	Total porosity as a fraction of root zone depth (it is converted to a unit of depth in IWFM by multiplying it with the root zone depth), [L/L]
K	Hydraulic conductivity of the root zone, [L/T]
CN	Curve Number with respect to soil type and land use type

Small Stream Watershed Groups

If no rain gages are specified in the Pre-processor, then this section should be skipped. The small stream watershed data specified in this file is related to each small stream watershed group defined. Each group can correspond to several small stream watersheds that have the same characteristics. In the boundary conditions data file, individual small stream watersheds are specified with respect to the groundwater nodes

they are connected to and the small stream watershed group they correspond to. The values listed below are necessary to define the impacts of small watersheds at the model boundary:

NSW	Number of small watershed groups
FACTL	Conversion factor for small stream watershed root zone depth and groundwater threshold value
FACTK	Conversion factor for small stream watershed hydraulic conductivity
FACTT	Conversion factor for recession coefficients
IS	Small watershed group identification number
IRNS	Rainfall station number associated with the small watershed
FRNS	Rainfall weighting factor for the small watershed
FLDCAS	Field capacity (multiplied by the root zone depth in IWFM to be converted to a unit of depth), [L/L]
TPOROS	Total porosity (multiplied by the root zone depth in IWFM to be converted to a unit of depth), [L/L]
CROOT	Root zone depth of native vegetation in the small watershed, [L]
SOILKS	Hydraulic conductivity of the root zone, [L/T]
CN	Curve number for small watershed area
GWSOS	Threshold value above which groundwater storage of small watershed contributes to surface runoff, [L]
SWKS	Recession coefficient for surface outflow, [1/T]
GWKS	Recession coefficient for base flow, [1/T]

Stream Bed Parameters

Values of hydraulic conductivity, thickness of streambed and the wetted perimeter are listed for each stream node in the system. Stream node numbers were input in the pre-processor stream specification input data file. Space is available at the end of each row to declare the stream name, this is optional. The list of stream bed parameters defined in this file is as follows:

FACTK	Conversion factor for stream bed conductivity
FACTL	Conversion factor for stream bed thickness and wetted perimeter
IR	Stream node number
CSTRM	Hydraulic conductivity of stream bed, [L/T]
DSTRM	Thickness of stream bed, [L]
WETPR	Wetter perimeter, [L]

Lake Parameters

Lake parameters for each lake modeled are defined in this file. The variables must be defined for each lake modeled in IWFM and are listed as follows:

FACTK	Conversion factor for lake bed conductivity
FACTL	Conversion factor for the thickness of lake bed
IL	Lake identification number
CLAKE	Hydraulic conductivity of the lake bed, [L/T]
DLAKE	Thickness of the lake bed, [L]
ICHLMAX	Column number in file unit 28 for maximum lake elevation

Water Use Parameters

If no land surface processes are modeled, i.e. no rain gages are specified in Pre-processor, the values defined below should not be specified. The water use parameters are defined by subregion and include the amount of pervious urban area, the re-use factors for the agricultural and urban return flow, and how the urban return flow is routed. Directly below the subregional water use parameter specification, the root zone depth is defined for each crop type modeled in IWFM:

IR	Subregion number
PERV	Fraction of pervious urban area to total urban area
ICRUFAG	Fraction of the surface runoff from agricultural applied water that is re-used (this number corresponds to the data column in irrigation water re-use factor data file, Unit 29)
ICRUFURB	Fraction of the surface runoff and return flow from urban areas that is re-used (this number corresponds to the data column in irrigation water re-use factor data file, Unit 29)
IURIND	Urban return flow specification. Return flow can leave the model boundary (-2), become groundwater recharge (-1), enter streams at the stream node that the element over which urban area lies is associated with (0); or more specifically, enter streams at a stream node, nd.
FACT	Conversion factor for crop root zone depths
IC	Crop type number
ROOT	Crop root zone depth, [L]

```
C*******************************************************************************
C
C                  INTEGRATED WATER FLOW MODEL (IWFM)
C                        *** Version ### ***
C
C*******************************************************************************
C
C                           PARAMETER DATA FILE
C                           for IWFM Simulation
C                                 (Unit 7)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  PARAMETER.DAT
C
C*******************************************************************************
C                            File Description:
C
C   This data file contains the aquifer parameters for each groundwater node
C   and each layer. The parameters may be set by using a parametric
C   grid to interpolate values or by listing values for each node
C   individually. In addition, this file contains the parameters for the
C   unsaturated zone, lakes, and stream beds along with field capacity and
C   wilting point for each soil type.
C
C*******************************************************************************
C                           AQUIFER PARAMETERS
C
C------------------------------------------------------------------------------
C   Option 1 - Set aquifer parameters by use of a parametric grid(NGROUP > 0)
C   Option 2 - Set aquifer parameters at every groundwater node  (NGROUP = 0)
C
C   NGROUP;  Number of parametric grid groups
C
C------------------------------------------------------------------------------
C       VALUE                    DESCRIPTION
C------------------------------------------------------------------------------
         6                       / NGROUP
C------------------------------------------------------------------------------
C   OPTIONS 1 & 2 : The following lists the factors to convert the aquifer
C   parameters and grid coordinates to the appropriate units
C
C   FX    ;  Conversion factor for parametric grid coordinates
C   FKH   ;  Conversion factor for horizontal hydraulic conductivity
C   FS    ;  Conversion factor for specific storage coefficient
C   FN    ;  Weighting factor for specific yield value
C   FV    ;  Conversion factor for aquitard vertical hydraulic conductivity
C   FL    ;  Conversion factor for aquifer vertical hydraulic conductivity
C   FSCE  ;  Conversion factor for elastic storage coefficient
C   FSCI  ;  Conversion factor for inelastic storage coefficient
C   FDC   ;  Conversion factor for interbed thickness
C   FDCMIN;  Conversion factor for minimum interbed thickness
C   FHC   ;  Conversion factor for pre-compaction hydraulic head
C
C-------------------------------------------------------------------------------------------------------------------------
C  FX       FKH         FS          FN         FV        FL       FSCE        FSCI        FDC         FDCMIN       FHC
C-------------------------------------------------------------------------------------------------------------------------
  3.281     1.0      0.000001       1.0        1.0       1.0     0.000001     0.002       1.0          1.0         1.0
C-------------------------------------------------------------------------------------------------------------------------
C*******************************************************************************
C                  OPTION 1 (for Aquifer Parameter Definition)
C*******************************************************************************
C------------------------------------------------------------------------------
C   *** GROUP 1 ***
C------------------------------------------------------------------------------
C   Enter node numbers from the FE grid for the 1st parametric group
C     (e.g. 1-100,101,301-359,567)
C------------------------------------------------------------------------------
     1-1393
C------------------------------------------------------------------------------
C
C   NDP;     Number of nodes in the 1st parametric grid
C   NEP;     Number of elements in the 1st parametric grid
C
C------------------------------------------------------------------------------
C   VALUE                        DESCRIPTION
C------------------------------------------------------------------------------
     33                         / NDP
     20                         / NEP
C------------------------------------------------------------------------------
C
C   The following is a list of the parametric elements and
C   corresponding parametric nodes for the 1st parametric group
C   (to be used only when parametric option is used, ie. NDP > 0)
C
C   IE  ;    Parametric element number
C   NODE;    Corresponding parametric node
C
C------------------------------------------------------------------------------
```

```
C             Node 1    Node 2    Node 3     Node 4
C    IE        NODE      NODE      NODE       NODE
C-------------------------------------------------------------------------------
      1         1         3         4          2
      2         3         5         6          4
      .         .         .         .          .
      .         .         .         .          .
      .         .         .         .          .
     19        28        31        32         29
     20        29        32        33         30
C-------------------------------------------------------------------------------
C
C   List the paramatric nodes, nodal coordinates and aquifer
C   parameters for each layer of the 1st parametric group
C   (enter -1.0 not to overwrite the previously set values)
C
C   ID   ;   Parametric node number
C   PX,PY;   Parametric node coordinates; [L]
C   PKH  ;   Hydraulic conductivity; [L/T]
C   PS   ;   Specific storage; [1/L]
C   PN   ;   Specific yield; [L/L]
C   PV   ;   Aquitard vertical hydraulic conductivity; [L/T]
C   PL   ;   Aquifer vertical hydraulic conductivity; [L/T]
C   SCE  ;   Elastic storage coefficient (Use SCE*DC if DC=0); [1/L]
C   SCI  ;   Inelastic storage coefficient (Use SCI*DC if DC=0); [1/L]
C   DC   ;   Interbed thickness;[L]
C   DCMIN;   Minimum interbed thickness; [L]
C   HC   ;   Pre-compaction hydraulic head (use 99999. to use initial heads); [L]
C            *Note* The above land subsidence parameters are only for interbed layers (i.e. clay layers)
C-------------------------------------------------------------------------------------------------------------------------
C  ID         PX       PY          PKH     PS       PN     PV       PL       SCE     SCI       DC      DCMIN       HC
C-------------------------------------------------------------------------------------------------------------------------
    1       526411   4488044     100.00     1.0     0.08   0.20     1.0      4.5    0.050     -1        2       99999.
                                 60.00      5.0     0.05   1.00     1.0      4.5    0.050     -1        2       99999.
                                 60.00      5.0     0.05   0.60     0.6      4.5    0.050     -1        2       99999.
    2       576022   4510977      80.00     1.0     0.09   0.20     1.0      4.5    0.050     -1        2       99999.
                                 40.00      5.0     0.05   1.00     1.0      4.5    0.050     -1        2       99999.
                                 40.00      5.0     0.05   0.60     0.6      4.5    0.050     -1        2       99999.
    .           .         .          .       .        .      .        .        .        .       .         .          .
                                     .       .        .      .        .        .        .       .         .          .
                                     .       .        .      .        .        .        .       .         .          .
    .           .         .          .       .        .      .        .        .        .       .         .          .
                                     .       .        .      .        .        .        .       .         .          .
                                     .       .        .      .        .        .        .       .         .          .
   33       899721   3868499      80.00     1.0     0.12   0.20     1.0      4.5     1.00     -1        2       99999.
                                 50.00      2.0     0.07   0.0001   0.1      4.5     1.00     -1        3       99999.
                                 20.00      3.0     0.07   0.60     0.6      4.5     1.00     -1        3       99999.
C-------------------------------------------------------------------------------------------------------------------------
C    *** GROUP 2 ***
C-------------------------------------------------------------------------------
C   Enter node numbers for the 2nd parametric group
C     (e.g. 1-100,101,301-359,567)
C-------------------------------------------------------------------------------
    1318-1321,1325,1329-1336,1339-1347,1349-1358,1360-1393
C-------------------------------------------------------------------------------
C
C   NDP;     Number of nodes in the 2nd parametric grid
C   NEP;     Number of elements in the 2nd parametric grid
C
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
     6                           / NDP
     2                           / NEP
C-------------------------------------------------------------------------------
C   Element   Node 1    Node 2    Node 3     Node 4
C    IE        NODE      NODE      NODE       NODE
C-------------------------------------------------------------------------------
      1         34        37        38         35
      2         35        38        39         36
C-------------------------------------------------------------------------------
C
C   List the paramatric nodes, nodal coordinates and aquifer
C   parameters for each layer of the 2nd parametric group
C   (enter -1.0 not to overwrite the previously set values)
C
C   ID   ;   Parametric node number
C   PX,PY;   Parametric node coordinates; [L]
C   PKH  ;   Hydraulic conductivity; [L/T]
C   PS   ;   Specific storage; [1/L]
C   PN   ;   Specific yield; [L/L]
C   PV   ;   Aquitard vertical hydraulic conductivity; [L/T]
C   PL   ;   Aquifer vertical hydraulic conductivity; [L/T]
C   SCE  ;   Elastic storage coefficient (Use SCE*DC if DC=0); [1/L]
C   SCI  ;   Inelastic storage coefficient (Use SCI*DC if DC=0); [1/L]
C   DC   ;   Interbed thickness;[L]
C   DCMIN;   Minimum interbed thickness; [L]
C   HC   ;   Pre-compaction hydraulic head (use 99999. to use initial heads); [L]
C            *Note* The above land subsidence parameters are only for interbed layers (i.e. clay layers)
C-------------------------------------------------------------------------------------------------------------------------
```

```
C  ID          PX        PY           PKH      PS        PN      PV        PL        SCE      SCI        DC      DCMIN       HC
C-------------------------------------------------------------------------------------------------------------------------------
   34       795918   3906758      100.      1.      .12      .2      1.0        -1       -1        -1       -1        -1
                                   80.      5.      .07     .002      .5        -1       -1        -1       -1        -1
                                   20.      3.      .07      .6       .6        -1       -1        -1       -1        -1
    .           .         .        .       .        .       .         .         .        .         .        .         .
                                    .       .        .       .         .         .        .         .        .         .
                                    .       .        .       .         .         .        .         .        .         .
    .           .         .        .       .        .       .         .         .        .         .        .         .
                                    .       .        .       .         .         .        .         .        .         .
                                    .       .        .       .         .         .        .         .        .         .
   39       905818   3868499      80.      1.      .12      .2      1.0        -1       -1        -1       -1        -1
                                   50.     10.      .07     .0015     .4        -1       -1        -1       -1        -1
                                    5.      8.      .07      .6       .6        -1       -1        -1       -1        -1
C-------------------------------------------------------------------------------------------------------------------------------
C    *** GROUP 3 ***
C-------------------------------------------------------------------------------
   .           .
   .           .
   .           .
C-----------------------------------------------------------------------------------------
C    *** GROUP 6 ***
C-------------------------------------------------------------------------------
C   Enter node numbers for the 6th parametric group
C     (e.g. 1-100,101,301-359,567)
C-------------------------------------------------------------------------------
 792  791  790  789  788  787  786  785
 784  769  768
 757  756  755  754  753  752  751  750
 749  728
 741  740  739  738  737  736  729
 715  702
 701  700  699  698  697  696  695  694
 693  683
 681  682
 671  660  649
 657  656  655  654  653  652  651  650  633
 623  622  621  620  619  618  617  616
 615  605  592  576  567  558
C-------------------------------------------------------------------------------
C
C   NDP;     Number of nodes in the 6th parametric grid
C   NEP;     Number of elements in the 6th parametric grid
C
C-------------------------------------------------------------------------------
C   VALUE                        DESCRIPTION
C-------------------------------------------------------------------------------
     1                           / NDP
     0                           / NEP
C-------------------------------------------------------------------------------
C   Element    Node 1    Node 2    Node 3     Node 4
C    IE         NODE      NODE      NODE       NODE
C-------------------------------------------------------------------------------
*
*
C-------------------------------------------------------------------------------
C
C   List the paramatric nodes, nodal coordinates and aquifer
C   parameters for each layer of the 6th parametric group
C
C   ID;      Parametric node number
C   PX,PY;   Parametric node coordinates [L]
C   PKH;     Hydraulic conductivity [L/T]
C   PS;      Specific storage [1/L]
C   PN;      Specific yield [FT/FT]
C   PV;      Aquitard vertical hydraulic conductivity [L/T]
C   PL;      Aquifer vertical hydraulic conductivity [L/T]
C   SCE;     Elastic storage coefficient (Use SCE*DC if DC=0) [1/L]
C   SCI;     Inelastic storage coefficient (Use SCI*DC if DC=0) [1/L]
C   DC;      Interbed thickness
C   DCMIN;   Minimum interbed thickness
C   HC;      Pre-compaction hydraulic head (use 99999. to use initial heads) [L]
C            *Note* The above land subsidence parameters are only for interbed layers (i.e. clay layers)
C-------------------------------------------------------------------------------------------------------------------------------
C  ID          PX        PY           PKH      PS        PN      PV        PL        SCE      SCI        DC      DCMIN       HC
C-------------------------------------------------------------------------------------------------------------------------------
   43     742369.0  3867036.0       40.    -1       -1     -1       -1       -1       -1       -1        -1       -1        -1
                                    -1     -1       -1     -1       -1       -1       -1       -1        -1       -1        -1
                                    -1     -1       -1     -1       -1       -1       -1       -1        -1       -1        -1
C-------------------------------------------------------------------------------
C*******************************************************************************
C                  OPTION 2 (for Aquifer Parameter Definition)
C*******************************************************************************
C
C    List the groundwater nodes, and aquifer parameters for
C    each layer (skip if option 1 is used)
C
C   ID   ;   Groundwater node number
C   PKH  ;   Hydraulic conductivity; [L/T]
C   PS   ;   Specific storage; [1/L]
```

```
C   PN   ;   Specific yield; [L/L]
C   PV   ;   Aquitard vertical hydraulic conductivity; [L/T]
C   PL   ;   Aquifer vertical hydraulic conductivity; [L/T]
C   SCE  ;   Elastic storage coefficient (Use SCE*DC if DC=0); [1/L]
C   SCI  ;   Inelastic storage coefficient (Use SCI*DC if DC=0); [1/L]
C   DC   ;   Interbed thickness; [L]
C   DCMIN;   Minimum interbed thickness; [L]
C   HC   ;   Pre-compaction hydraulic head (use 99999. to use initial heads); [L]
C            *Note* The above land subsidence parameters are only for interbed layers (i.e. clay layers)
C
C-------------------------------------------------------------------------------
C                          Layer  1
C                          Layer  2
C                             .
C                             .
C
C         Hydr.   Spec.    Spec.  Aquitard  Aquifer   Elastic   Inelastic   Interbed   Min. Intrbd   Precompc
C         cond.   Stor.    Yld.    Vert. K  Vert. K  Stg. Coef. Stg. Coef.  Thickness   Thickness    Hyd. Head
C  ID      PKH     PS       PN       PV        PL       SCE        SCI         DC        DCMIN          HC
C-------------------------------------------------------------------------------------------------------------
*
C-------------------------------------------------------------------------------------------------------------
C*******************************************************************************
C                      ANOMALY IN HYDRAULIC CONDUCTIVITY
C
C   List the groundwater elements and corresponding aquifer
C   parameters for nodes that will overwrite the above aquifer data
C
C   NEBK;  Number of elements where hydraulic conductivity
C             values will be overwritten
C   FACT;  Conversion factor for the anomaly hydraulic conductivity
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
      7                         / NEBK
      1.0                       / FACT
C-------------------------------------------------------------------------------
C
C   IC  ;    Counter for number of overwrite options
C   IEBK;    Element number corresponding to counter IC
C   BK  ;    Hydraulic conductivity at the specified node; [L/T]
C-------------------------------------------------------------------------------
C                           LAYER 1   LAYER 2   LAYER 3
C     IC          IEBK        BK        BK        BK
C-------------------------------------------------------------------------------
       1           55        .2        .2        .2
       2           56        .2        .2        .2
       3           57        .2        .2        .2
       4           58        .2        .2        .2
       5         1383        .001      .001      .001
       6         1384        .001      .001      .001
       7         1385        .001      .001      .001
C*******************************************************************************
C                         UNSATURATED ZONE PARAMETERS
C            (Skip if no rain gages are specified in the pre-processor)
C
C   NUNSAT;  Number of layers in the unsaturated zone
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
     2                          / NUNSAT
C-------------------------------------------------------------------------------
C   Option 1 - Set unsaturated zone parameters by use of a parametric grid(NGROUP > 0)
C   Option 2 - Set unsaturated zone parameters at every groundwater node  (NGROUP = 0)
C
C   NGROUP;  Number of parametric grid groups
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
     0                          / NGROUP
C-------------------------------------------------------------------------------
C   OPTIONS 1 & 2 : The following lists the factors to convert the unsaturated
C                   zone parameters and grid coordinates to the appropriate units
C
C
C   FX;      Conversion factor for grid coordinates
C   FD;      Conversion factor for the thickness of the unsaturated layer
C   FN;      Weighting factor for unsaturated zone porosity
C   FL;      Conversion factor for hydraulic conductivity
C
C-------------------------------------------------------------------------------
C    FX             FD            FN            FL
C-------------------------------------------------------------------------------
     1.0            1.0           1.0           1.0
C-------------------------------------------------------------------------------
C*******************************************************************************
C            OPTION 1 (for Unsaturated Zone Parameter Definition)
C*******************************************************************************
C-------------------------------------------------------------------------------
C   *** GROUP 1 ***
```

```
C-------------------------------------------------------------------------------
C   Enter node numbers for the 1st parametric group
C     (e.g. 1-100,101,301-359,567)
C-------------------------------------------------------------------------------
*
C-------------------------------------------------------------------------------
C
C   NDP;     Number of nodes in the 1st parametric grid
C   NEP;     Number of elements in the 1st parametric grid
C
C-------------------------------------------------------------------------------
C   VALUE                      DESCRIPTION
C-------------------------------------------------------------------------------
*                               / NDP
*                               / NEP
C-------------------------------------------------------------------------------
C
C   The following is a list of the parametric elements and
C   corresponding parametric nodes for the 1st parametric group
C   (to be used only when parametric option is used, ie. NDP > 0)
C
C   IE  ;    Parametric element number
C   NODE;    Corresponding parametric node
C
C-------------------------------------------------------------------------------
C            Node 1    Node 2    Node 3     Node 4
C    IE       NODE      NODE      NODE       NODE
C-------------------------------------------------------------------------------
*
C-------------------------------------------------------------------------------
C    List the parametric nodes,coordinates, and unsaturated zone parameters for
C    each layer of the 1st parametric group (skip if option 2 is used)
C
C   ID;      Parametric node number
C   PX;      x-coordinate of the parametric node; [L]
C   PY;      y-coordinate of the parametric node; [L]
C   PD;      Thickness of unsaturated layer; [L]
C   PN;      Effective porosity; [L/L]
C   PL;      Hydraulic conductivity; [L/T]
C-------------------------------------------------------------------------------
C          NODAL COORDINATES     Thickness     Porosity    Hyd. Cond.
C   ID       PX      PY              PD           PN           PL
C-------------------------------------------------------------------------------
*
C-------------------------------------------------------------------------------
C    *** GROUP 2 ***
C-------------------------------------------------------------------------------
C   Enter node numbers for the 2nd parametric group
C     (e.g. 1-100,101,301-359,567)
C-------------------------------------------------------------------------------
*
C-------------------------------------------------------------------------------
C
C   NDP;     Number of nodes in the 2nd parametric grid
C   NEP;     Number of elements in the 2nd parametric grid
C
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
*                                / NDP
*                                / NEP
C-------------------------------------------------------------------------------
C   Element   Node 1    Node 2    Node 3     Node 4
C    IE        NODE      NODE      NODE       NODE
C-------------------------------------------------------------------------------
*
C-------------------------------------------------------------------------------
C    List the parametric nodes,coordinates, and unsaturated zone parameters for
C    each layer of the 2nd parametric group (skip if option 2 is used)
C
C   ID;      Parametric node number
C   PX;      x-coordinate of the parametric node; [L]
C   PY;      y-coordinate of the parametric node; [L]
C   PD;      Thickness of unsaturated layer; [L]
C   PN;      Effective porosity; [L/L]
C   PL;      Hydraulic conductivity; [L/T]
C-------------------------------------------------------------------------------
C          NODAL COORDINATES     Thickness     Porosity    Hyd. Cond.
C   ID       PX      PY              PD           PN           PL
C-------------------------------------------------------------------------------
*
C-------------------------------------------------------------------------------
C*******************************************************************************
C            OPTION 2 (for Unsaturated Zone Parameter Definition)
C*******************************************************************************
C
C   List the groundwater elements and unsaturated zone parameters for
C   each layer (skip if option 1 is used)
C
C   IE;      Element number
```

```
C   PD;      Thickness of unsaturated layer; [L]
C   PN;      Total porosity; [L/L]
C   PK;      Hydraulic conductivity; [L/T]
C-------------------------------------------------------------------------------
C                          LAYER 1                            LAYER 2
C       IE          PD         PN       PL             PD        PN        PL
C-------------------------------------------------------------------------------
         1         49.900      .120     1.000           0.000   .120     1.000
         2         49.900      .120     1.000           0.000   .120     1.000
         .            .         .        .               .       .         .
         .            .         .        .               .       .         .
         .            .         .        .               .       .         .
      1391         49.900      .120     1.000           0.000   .120     1.000
      1392         49.900      .120     1.000           0.000   .120     1.000
C-------------------------------------------------------------------------------
C*******************************************************************************
C                   PARAMETERS FOR SOIL MOISTURE ROUTING
C
C   The following lists the soil moisture and hydrologic properties for each
C   hydrologic soil group  (A,B,C,D) by subregion .
C    *Note* This portion of the parameter input should be skipped if no
C           rain gages are specified in file unit 13 during pre-processing
C-------------------------------------------------------------------------------
C
C   FACT;   Conversion factor for root zone hydraulic conductivity
C
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
    1.0                         / FACT
C-------------------------------------------------------------------------------
C
C   IREGN;      Subregion number
C   FC   ;      Field capacity; [L/L]
C   EF   ;      Total porosity; [L/L]
C   K    ;      Hydraulic conductivity of the root zone; [L/T]
C   CN   ;      Curve number depending on the land use type:
C                1-Agricultural ; 2-Urban ; 3-Native veg. ; 4-Riparian veg.
C               (Reference: USDA, 1985)
C
C-------------------------------------------------------------------------------------------------------------------------
C          SOIL GROUP A                SOIL GROUP B                SOIL GROUP C                SOIL GROUP D
C IREGN ------------------------  ------------------------  ------------------------  ----------------------
C                    CN BY LAND                  CN BY LAND                  CN BY LAND                  CN BY L
C       FC  EF  K  --------------    FC  EF  K  --------------    FC  EF  K  --------------    FC  EF  K  ---------
C                   1   2   3   4               1   2   3   4               1   2   3   4               1   2
C-------------------------------------------------------------------------------------------------------------------------
  1    .06 .20 0.2  68  73  70  65  .08 .20 0.1  74  78  75  65    .10 .25 0.05  87 90  84  75   .10 .30 0.02   92  95
  2    .06 .20 0.5  68  73  70  65  .08 .20 0.2  74  78  75  65    .10 .25 0.1   87 90  84  75   .10 .30 0.05   92  95
  .      .   .   .   .   .   .   .    .   .   .   .   .   .   .      .   .   .    .  .   .   .     .   .   .    .   .
  .      .   .   .   .   .   .   .    .   .   .   .   .   .   .      .   .   .    .  .   .   .     .   .   .    .   .
  .      .   .   .   .   .   .   .    .   .   .   .   .   .   .      .   .   .    .  .   .   .     .   .   .    .   .
 20    .06 .20 0.1  68  73  70  65  .08 .20 0.05 74  78  75  65    .10 .25 0.01  87 90  84  75   .10 .30 0.005  92  95
 21    .06 .20 0.2  68  73  70  65  .08 .20 0.1  74  78  75  65    .10 .25 0.05  87 90  84  75   .10 .30 0.005  92  95
C*******************************************************************************
C                         SMALL STREAM WATERSHED DATA
C
C   The following  lists the small watershed parameters that are used in the
C   computation of runoff from the tributary watersheds outside the model boundary.
C
C *Note* This portion of the parameter input should be skipped if no rain gages
C        are specified in file unit 13 during pre-processing
C
C
C   NSW   ;   Number of small watershed groups
C   FACTL ;   Conversion factor for root zone depth and groundwater threshold value
C   FACTK ;   Conversion factor for hydraulic conductivity
C   FACTT ;   Conversion factor for recession coefficients
C   IS    ;   Small watershed group identification number
C   IRNS  ;   Rainfall station number associated with the small watershed
C   FRNS  ;   Rainfall weighting factor for the small watershed
C   FLDCAS;   Field capacity; [L/L]
C   TPOROS;   Total porosity; [L/L]
C   CROOT ;   Root zone depth of native vegetation in the small watershed; [L]
C   SOILKS;   Hydraulic conductivity of the root zone; [L/T]
C   CN    ;   Curve number for small watershed area
C             (Reference: USDA, 1985)
C   GWSOS ;   Threshold value of groundwater depth above which groundwater
C                storage of small watershed contributes to surface runoff; [L]
C   SWKS  ;   Recession coefficient for surface outflow; [1/T]
C   GWKS  ;   Recession coefficient for base flow; [1/T]
C
C-------------------------------------------------------------------------------
C   VALUE                 DESCRIPTION
C-------------------------------------------------------------------------------
     15                   / NSW
     1.0                  / FACTL
     1.0                  / FACTK
     1.0                  / FACTT
C-------------------------------------------------------------------------------
```

```
C IS   IRNS    FRNS  FLDCAS TPOROS CROOT  SOILKS   CN   GWSOS    SWKS  GWKS
C-------------------------------------------------------------------------------
  1     29     3.00   .08   .10       3    1.00    80    10.       0.4  0.002
  .      .        .     .     .        .       .     .     .         .      .
  .      .        .     .     .        .       .     .     .         .      .
  .      .        .     .     .        .       .     .     .         .      .
  15    32     3.50   .08   .08       3    1.00    80    10.       0.4  0.002
C*******************************************************************************
C                       STREAM BED PARAMETERS
C
C     The following lists the parameters to model streams.
C     *Note* Skip data input if no streams are modeled
C
C   FACTK;   Conversion factor for stream bed conductivity
C   FACTL;   Conversion factor for stream bed thickness and wetted perimeter
C   IR   ;   Stream node number
C   CSTRM;   Hydraulic conductivity of stream bed; [L/T]
C   DSTRM;   Thickness of stream bed; [L]
C   WETPR;   Wetted perimeter; [L]
C
C-------------------------------------------------------------------------------
C   VALUE                 DESCRIPTION
C-------------------------------------------------------------------------------
     1.0                  / FACTK
     1.0                  / FACTL
C-------------------------------------------------------------------------------
C    IR       CSTRM       DSTRM      WETPR        River Name (Optional)
C-------------------------------------------------------------------------------
      1        4.0         1.         200.0
      2        4.0         1.         200.0
      .          .         .            .
      .          .         .            .
      .          .         .            .
    430        0.0         1.         200.0
    431        0.0         1.         200.0
C*******************************************************************************
C                         LAKE PARAMETERS
C
C     The parameters required to model lakes are listed below.
C     *Note* Skip data input if no lakes are modeled
C
C   FACTK  ;   Conversion factor for lake bed hydraulic conductivity
C   FACTL  ;   Conversion factor for thickness of lake bed
C   IL     ;   Lake number
C   CLAKE  ;   Hydraulic conductivity of the lake bed; [L/T]
C   DLAKE  ;   Thickness of the lake bed; [L]
C   ICHLMAX;   Column number in file unit 28 for maximum lake elevation
C
C-------------------------------------------------------------------------------
C   VALUE                 DESCRIPTION
C-------------------------------------------------------------------------------
     1.0                  / FACTK
     1.0                  / FACTL
C-------------------------------------------------------------------------------
C   IL       CLAKE      DLAKE      ICHLMAX     Lake Name (Optional)
C-------------------------------------------------------------------------------
     1         1.0      20.0          1
     2         1.0      20.0          2
C*******************************************************************************
C                       WATER USE PARAMETERS
C
C   The following lists the water use parameters for each subregion and the
C   crop root zone depth for each crop type including urban (lawn) and
C   native vegetation (skip if soil moisture is not routed,
C   i.e. if there are no rain gages)
C
C   IR       ;  Subregion number
C   PERV     ;  Fraction of pervious area to total urban areas
C   ICRUFAG  ;  Fraction of the surface runoff from agricultural applied water
C                that is re-used - this number corresponds to the appropriate data
C                column in irrigation water re-use factor data file (Unit 29)
C   ICRUFURB ;  Fraction of the surface runoff and return flow from urban areas
C                that is re-used - this number corresponds to the appropriate data
C                column in irrigation water re-use factor data file (Unit 29)
C   IURIND   ;  Urban return flow specification
C                  -2;   Urban return flow goes out of model boundary
C                  -1;   Urban return flow goes into groundwater recharge
C                   0;   Urban return flow enters streams
C                  nd;   Urban return flow enters streams at stream node, nd
C
C-------------------------------------------------------------------------------
C   IR    PERV    ICRUFAG   ICRUFURB    IURIND
C-------------------------------------------------------------------------------
     1    .62        1        22         -1
     2    .62        2        22         -1
     .      .        .         .          .
     .      .        .         .          .
     .      .        .         .          .
    20    .62       20        22         -1
    21    .62       21        22          0
C-------------------------------------------------------------------------------------
C
C   FACT;    Conversion factor for crop root zone depths
C   IC  ;    Crop type number
```

```
C   ROOT;    Crop root zone depth; [L]
C
C-------------------------------------------------------------------------------
C   VALUE                 DESCRIPTION
C-------------------------------------------------------------------------------
     1.0                  / FACT
C-------------------------------------------------------------------------------
C   IC          ROOT
C-------------------------------------------------------------------------------
     1           2.0
     2           6.0
     .             .
     .             .
     .             .
    16           3.0
    17           5.0
```

Boundary Conditions File Unit 8

The following types of boundary conditions can be input into the boundary data file for each aquifer layer modeled:

1. Specified flow
2. Specified head
3. Rating tables
4. General head

Small stream watersheds are also listed in this file. For each aquifer layer, boundary conditions 1-4 are specified, followed by the small stream watershed boundary conditions. The number of boundary condition nodes for a layer must be specified as zero for the conditions not used in the simulation.

Specified Flow

Specified flow boundary conditions are defined when the flow is known across surfaces bounding the domain. The number of nodes with a specified flow, the conversion factor, followed by the list of nodes and associated flow terms are required input for specified flow boundary conditions. The variables used to describe the input data are as follows:

NQB	Number of nodes with specified flow
FACT	Conversion factor for specified flow data
INODE	Groundwater node with a specified flow
BQ	Specified flow value at groundwater node INODE (if BQ is less than –10000, then –BQ–10000 indicates the column number in the time series boundary conditions data file), [L^3/T]

Specified Head

Specified head boundary conditions are input when the hydraulic head is known for surfaces bounding the domain. The number of boundary nodes with specified head values, conversion factor and each node and the related hydraulic head are defined in the input file in the following terms:

NHB	Number of groundwater nodes with specified head
FACT	Conversion factor for specified head
INODE	Groundwater node with a specified head
BH	Specified head value for node INODE (if less than −10000.0, then –BH−10000.0 indicates the column number corresponding to the time series boundary condition data), [L]

Rating Tables

Rating table boundary conditions are implemented when the rate of flow at the boundary can be determined as a function of the groundwater head. The number of nodes with a rating table condition, the number of points in each rating table, and the conversion factors for the head and flow rate are specified. This information is followed by each groundwater node with a rating table boundary condition and the corresponding head value and flow rate. The list of the description of variables for rating table boundary conditions is:

NMB	Number of nodes with a rating table boundary condition
NMTB	Number of points in the rating table

FACTH	Conversion factor for the head value
FACTQ	Conversion factor for flow rate
INODE	Node number corresponding to a rating table boundary condition
HMTB	Head value, [L]
QMTB	Flow rate at the specified head HMTB, [L^3/T]

General Head

General head boundary conditions are defined when head values at a specified distances from boundary nodes are known. The number of general head boundary nodes is listed, followed by the conversion factors. This information is followed by the node numbers with a general head boundary condition and the related hydraulic head, area of influence and distance from each node. The following must be specified in this input to declare general head boundary conditions:

NGB	Number of groundwater nodes with general head boundary conditions
FACTH	Conversion factor for the head value
FACTAR	Conversion factor for area
INODE	Node number corresponding to the general head boundary condition
BH	Fixed head at distance BD from the groundwater node INODE (if less than −10000.0, then –BH−10000.0 indicates the column number in the time series boundary condition data), [L]
BA	Area of influence surrounding groundwater node INODE, [L^2]

BD Distance from the groundwater node INODE to the source of the fixed head BH, [L]

Small Stream Watersheds

To account for flow from small stream watershed into the model domain, surface and subsurface flows leaving the small stream watershed and entering the model domain are simulated with an approximate method. The boundary condition values are implemented into the groundwater equation based on the computation of surface and subsurface flow using values defined in this file.

The surface runoff and groundwater recharge characteristics are specified for each small stream watershed modeled. Defined in this file is the number of small stream watersheds, stress period to be used as a constant multiplier of the time step, and related conversion factors. The following input includes each small watershed identification number and the related surface and subsurface information. The drainage area of the small watershed must be input, followed by the stream node within the model where surface runoff flows. The number of groundwater nodes that correspond to the small watershed is followed by a list that defines each groundwater identification number and the maximum recharge rate to that groundwater node during a single stress period. A value of -1 for the maximum recharge rate indicates that the subsurface flow will be directly contributed to groundwater nodes, whereas a positive value indicates the maximum amount of water that can percolate to the groundwater when routed from the small watershed to stream node IWBTS.

NTWB	Number of small watersheds where inflows will be computed and specified as boundary flow
NSPW	Stress period for small watersheds (expressed as an integer multiplier of the time step)
FACTA	Conversion factor for small watershed drainage area
FACTQ	Conversion factor for maximum recharge rate
ID	Small watershed identification number
IWBS	Watershed group number corresponding to the numbers and parameters specified for watersheds in the parameter data file Unit 7
AREAS	Drainage area of the small watershed, [L^2]
IWBTS	Stream node that gains small watershed surface runoff contribution
NWB	Number of groundwater nodes that correspond with the small watershed
IWB	Groundwater node number small watershed baseflow is routed through
QMAXWB	Maximum recharge rate for each node [L^3/T]; a value of −1 is entered to specify the groundwater node that receives baseflow from the small watersheds, whereas a positive value indicates the amount of water that can percolate through the small stream to the groundwater

```
C*******************************************************************************
C
C                  INTEGRATED WATER FLOW MODEL (IWFM)
C                        *** Version ### ***
C
C*******************************************************************************
C
C                  BOUNDARY CONDITIONS DATA FILE
C                      for IWFM Simulation
C                           (Unit 8)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  BOUND.DAT
C
C*******************************************************************************
C                          File Description:
C
C   This data file contains five types of boundary conditions for each layer.
C   The boundary conditions are set as constant head, prescribed flux,
C   rating table and general head for each layer which is to be followed by
C   boundary conditions for small watershed inflow computation.
C
C*******************************************************************************
C
C                       Layer 1  Boundary Conditions
C
C   The following lists the specified flux, constant head, rating table
C   and general head boundary conditions for Layer 1
C
C-------------------------------------------------------------------------------
C            Specified flux boundary conditions specifications (Layer 1)
C
C   NQB ;    Number of nodes with specified flux
C   FACT;    Conversion factor for specified flux data
C
C  *Note* If the specified flux is zero, the nodes do not need to be specified
C-------------------------------------------------------------------------------
C   VALUE                        DESCRIPTION
C-------------------------------------------------------------------------------
     0                           / NQB
     1.0                         / FACT
C-------------------------------------------------------------------------------
C
C              Specified flux boundary condition data (Layer 1)
C      (Skip if there are no nodes with a specified flux, i.e. NQB = 0)
C
C   INODE;   Groundwater node with a specified flux
C   BQ   ;   Specified flux value at groundwater node INODE; [L^3/T]
C              (If less than -10000.0, then -(BQ+10000.0) indicates the column
C               number in unit 9 corresponding to the time series boundary
C               condition data)
C-------------------------------------------------------------------------------
C     INODE     BQ
C-------------------------------------------------------------------------------
*
*
C-------------------------------------------------------------------------------
C*******************************************************************************
C
C          Specified head boundary conditions specifications (Layer 1)
C
C   NHB ;    Number of groundwater nodes with specified head
C   FACT;    Conversion factor for specified head data
C-------------------------------------------------------------------------------
C   VALUE                        DESCRIPTION
C-------------------------------------------------------------------------------
     21                          / NHB
     1.0                         / FACT
C-------------------------------------------------------------------------------
C
C              Specified head boundary condition data (Layer 1)
C   (Skip if there are no nodes with a specified head, i.e. NHB = 0)
C
C   INODE;   Groundwater node with a specified head
C   BH   ;   Specified head value for node INODE relative to a common datum; [L]
C              (If less than -10000.0, then -(BH+10000.0) indicates the column
C               number in unit 9 corresponding to the time series boundary
C               condition data)
C-------------------------------------------------------------------------------
C    INODE     BH
C-------------------------------------------------------------------------------
      1        290.0
      22       290.0
      43       290.0
      64       290.0
      85       290.0
      106      290.0
      127      290.0
      148      290.0
```

```
      169      290.0
      190      290.0
      211      290.0
      232      290.0
      253      290.0
      274      290.0
      295      290.0
      316      290.0
      337      290.0
      358      290.0
      379      290.0
      400      290.0
      421      290.0
C-------------------------------------------------------------------------------
C*******************************************************************************
C
C            Rating table boundary conditions specifications (Layer 1)
C
C   NMB  ;   Number of nodes with a rating table boundary condition
C   NMTB ;   Number of points in the rating table
C   FACTH;   Conversion factor for head value
C   FACTQ;   Conversion factor for flow rate
C-------------------------------------------------------------------------------
C       VALUE                   DESCRIPTION
C-------------------------------------------------------------------------------
         0                     / NMB
         0                     / NMTB
         1.0                   / FACTH
         1.0                   / FACTQ
C-------------------------------------------------------------------------------
C
C              Rating table boundary condition data (Layer 1)
C  (Skip if there are no nodes with rating table boundary conditions, ie. NMB = 0)
C
C   INODE;   Node number corresponding to a rating table boundary condition
C   HMTB ;   Head value; [L]
C   QMTB ;   Flow rate at the specified head HMTB; [L^3/T]
C
C-------------------------------------------------------------------------------
C   INODE       HMTB         QMTB
C-------------------------------------------------------------------------------
*
*
C-------------------------------------------------------------------------------
C*******************************************************************************
C
C            General head boundary conditions specifications (Layer 1)
C
C   NGB   ;  Number of groundwater nodes with general head boundary conditions
C   FACTH ;  Conversion factor for head
C   FACTAR;  Conversion factor for area
C-------------------------------------------------------------------------------
C       VALUE                   DESCRIPTION
C-------------------------------------------------------------------------------
        0                      / NGB
        1.0                    / FACTH
        1.0                    / FACTAR
C-------------------------------------------------------------------------------
C
C             General head boundary conditions data (Layer 1)
C  (Skip if there are no nodes with general head boundary conditions, ie. NGB = 0)
C
C
C   INODE;   Node number corresponding to the general head boundary condition
C   BH   ;   Fixed head at the distance BD from the groundwater node INODE; [L]
C              (If less than -10000.0, then -(BH+10000.0) indicates the column
C               number in unit 9 corresponding to the time series boundary
C               codition data)
C   BA;      Area of influence surrounding groundwater node INODE; [L^2]
C   BD;      Distance from the groundwater node INODE to the source of the
C             fixed head BH; [L]
C-------------------------------------------------------------------------------
C   INODE       BH        BA         BD
C-------------------------------------------------------------------------------
*
*
C*******************************************************************************
C
C                     Layer 2 Boundary Conditions
C
C   The following lists the specified flux, constant head, rating table
C   and general head boundary conditions for Layer 2
C
C-------------------------------------------------------------------------------
C            Specified flux boundary conditions specifications (Layer 2)
C
C   NQB ;    Number of nodes with specified flux
C   FACT;    Conversion factor for specified flux data
C
C  *Note* If the specified flux is zero, the nodes do not need to be specified
```

```
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
*                               / NQB
*                               / FACT
C-------------------------------------------------------------------------------
C
C              Specified flux boundary condition data (Layer 2)
C      (Skip if there are no nodes with a specified flux, i.e. NQB = 0)
C
C   INODE;   Groundwater node with a specified flux
C   BQ   ;   Specified flux value at groundwater node INODE; [L^3/T]
C              (If less than -10000.0, then -(BQ+10000.0) indicates the column
C               number in unit 9 corresponding to the time series boundary
C               condition data)
C-------------------------------------------------------------------------------
C     INODE     BQ
C-------------------------------------------------------------------------------
*
*
C-------------------------------------------------------------------------------
C*******************************************************************************
C
C          Specified head boundary conditions specifications (Layer 2)
C
C   NHB ;    Number of groundwater nodes with specified head
C   FACT;    Conversion factor for specified head data
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
*                               / NHB
*                               / FACT
C-------------------------------------------------------------------------------
C
C              Specified head boundary condition data (Layer 2)
C   (Skip if there are no nodes with a specified head, i.e. NHB = 0)
C
C   INODE;   Groundwater node with a specified head
C   BH   ;   Specified head value for node INODE relative to a common datum; [L]
C              (If less than -10000.0, then -(BH+10000.0) indicates the column
C               number in unit 9 corresponding to the time series boundary
C               condition data)
C-------------------------------------------------------------------------------
C    INODE     BH
C-------------------------------------------------------------------------------
*
*
C-------------------------------------------------------------------------------
C*******************************************************************************
C
C            Rating table boundary conditions specifications (Layer 2)
C
C   NMB  ;   Number of nodes with a rating table boundary condition
C   NMTB ;   Number of points in the rating table
C   FACTH;   Conversion factor for head value
C   FACTQ;   Conversion factor for flow rate
C-------------------------------------------------------------------------------
C       VALUE                   DESCRIPTION
C-------------------------------------------------------------------------------
*                              / NMB
*                              / NMTB
*                              / FACTH
*                              / FACTQ
C-------------------------------------------------------------------------------
C
C              Rating table boundary condition data (Layer 2)
C  (Skip if there are no nodes with rating table boundary conditions, ie. NMB = 0)
C
C   INODE;   Node number corresponding to a rating table boundary condition
C   HMTB ;   Head value; [L]
C   QMTB ;   Flow rate at the specified head HMTB; [L^3/T]
C
C-------------------------------------------------------------------------------
C   INODE       HMTB         QMTB
C-------------------------------------------------------------------------------
*
*
C-------------------------------------------------------------------------------
C*******************************************************************************
C
C            General head boundary conditions specifications (Layer 2)
C
C   NGB   ;  Number of groundwater nodes with general head boundary conditions
C   FACTH ;  Conversion factor for head
C   FACTAR;  Conversion factor for area
C-------------------------------------------------------------------------------
C       VALUE                   DESCRIPTION
C-------------------------------------------------------------------------------
*                               / NGB
*                               / FACTH
```

```
*                              / FACTAR
C-------------------------------------------------------------------------------
C
C             General head boundary conditions data (Layer 2)
C  (Skip if there are no nodes with general head boundary conditions, ie. NGB = 0)
C
C
C   INODE;   Node number corresponding to the general head boundary condition
C   BH   ;   Fixed head at the distance BD from the groundwater node INODE; [L]
C              (If less than -10000.0, then -(BH+10000.0) indicates the column
C               number in unit 9 corresponding to the time series boundary
C               codition data)
C   BA;      Area of influence surrounding groundwater node INODE; [L^2]
C   BD;      Distance from the groundwater node INODE to the source of the
C             fixed head BH; [L]
C-------------------------------------------------------------------------------
C   INODE       BH        BA         BD
C-------------------------------------------------------------------------------
*
*
C-------------------------------------------------------------------------------
C*******************************************************************************
C
C          Boundary Conditions for Small Watershed Inflow Computation
C
C   NTWB  ; Number of small watersheds where inflows will be computed
C             and specified as boundary flux
C   NSPW  ; Stress period for small watersheds
C             (expressed as an integer multiplier of the time step)
C   FACTA ; Conversion factor for small watershed drainage area
C   FACTQ ; Conversion factor for maximum recharge rate
C   ID    ; Small watershed identification number
C   IWBS  ; Watershed group number corresponding to the watershed parameter
C             groups specified in the parameter data file Unit 7
C   AREAS ; Drainage area of the small watershed; [L^2]
C   IWBTS ; Stream node that receives the surface runoff from the small watershed
C   NWB   ; Number of groundwater nodes that receive the base flow and the
C             percolation of surface flow from the small watershed
C   IWB   ; Groundwater node number small watershed baseflow is routed through
C   QMAXWB; Maximum recharge rate for each node; [L^3/T]
C            (Enter -1 to specify which groundwater node(s) receive baseflow
C             from the small watersheds)
C
C   *Note*   Skip data input if no small watersheds are modeled (NSW=0)
C-------------------------------------------------------------------------------
C       VALUE                   DESCRIPTION
C-------------------------------------------------------------------------------
         3                      / NTWB
         30                     / NSPW
         1000000.0              / FACTA
         1000.0                 / FACTQ
C-------------------------------------------------------------------------------
C ID     IWBS    AREAS   IWBTS     NWB    IWB      QMAXWB
C-----------------------------------------------------------------
  1        1      6.0      1        2      432       -1
                                           433       -1
  2        1      5.0      3        3      436       -1
                                           414       10.0
                                           392        5.0
  3        2      5.0      21       2       15       -1
                                           35         2.0
```

Time Series Boundary Condition File Unit 9

This file identifies the time series data for specified head, specified flow and general head boundary conditions. The groundwater node numbers that correspond to the columns listed in this file are specified in the boundary conditions data file (Unit 8). If both specified head and specified flow boundary conditions are listed, then each column has to have either only head values or only flow rate values. The parameters specified in this file are as follows:

NBTSD	Number of columns
FACTHTS	Conversion factor for head values
FACTQTS	Conversion factor for flow values
NSPHTS	Number of time steps to update the boundary condition head values
NFQHTS	Repetition frequency of the time series boundary condition data (enter zero if full time series data is supplied)
ITHTS	Time
HQTS	Time series boundary values, [L] or [L^3/T] depending on if specified head or specified flow values are listed in a column

```
C*******************************************************************************
C
C                  INTEGRATED WATER FLOW MODEL (IWFM)
C                        *** Version ### ***
C
C*******************************************************************************
C
C                   TIME SERIES BOUNDARY CONDITION DATA
C                           for IWFM Simulation
C                               (Unit 9)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  BOUNDTSD.DAT
C
C*******************************************************************************
C                          File Description
C
C   This data file contains the time series data for the specified flow,
C   specified head and/or general head boundary conditions. The file provides
C   time series data for the groundwater nodes specified in boundary condition
C   data file (Unit 8).
C
C*******************************************************************************
C                     Time Series Boundary Condition Specifications
C
C   The following lists the time series values for the groundwater nodes
C   specified in Unit 8.
C
C   NBTSD  ; Number of columns
C   FACTHTS; Conversion factor for head values
C   FACTQTS; Conversion factor for flow values
C   NSPHTS;  Number of time steps to update the time series boundary condition data
C   NFQHTS;  Repetition frequency of the time series boundary condition data
C             (enter 0 if full time series data is supplied)
C
C-------------------------------------------------------------------------------
C   VALUE                        DESCRIPTION
C-------------------------------------------------------------------------------
     5                           / NBTSD
     1.0                         / FACTHTS
     1.0                         / FACTQTS
     30                          / NSPHTS
     0                           / NFQHTS
C-------------------------------------------------------------------------------
C                     Time Series Boundary Condition Data
C
C   ITHTS;  Time
C   HQTS ;  Time series boundary values; [L] or [L^3/T]
C
C-------------------------------------------------------------------------------------
C   ITHTS   HQTS(1)  HQTS(2)  HQTS(3) ...
C-------------------------------------------------------------------------------------
        1    8.2      7.2      6.8      5.7      4.9
       31    8.1      7.1      6.6      5.6      4.7
       61    9.3      8.3      7.8      6.7      5.7
        .     .        .        .        .        .
        .     .        .        .        .        .
        .     .        .        .        .        .
    11071    4.8      4.1      3.6      3.1      2.7
    11101    4.8      4.2      3.8      3.2      2.9
    11131    5.5      4.9      4.5      3.9      3.6
```

Printing Control File Unit 10

This data file contains the instructions for printing groundwater, stream and tile drain/subsurface irrigation hydrograph information as well as the flow at boundary nodes and element faces. The tile drain/subsurface irrigation hydrographs are printed to Unit 45, stream hydrographs to Unit 46 and the groundwater hydrographs to Unit 47. The element face flows are printed to Unit 43 and the boundary node flows to Unit 44.

Groundwater hydrographs can be printed at specified groundwater nodes or at locations defined by x-y coordinates and layer number. The data file requires the user to specify the number of groundwater hydrographs to be printed (NOUTH) and the conversion factor for nodal coordinates (FACT). If the groundwater hydrographs are required for specified groundwater nodes at specified layers, then FACT should be set to zero. If the groundwater hydrographs are required for specified x-y coordinates and specified layers, then FACT should be set to the actual conversion factor. If hydrographs at a mixture of groundwater nodes and x-y coordinate locations are required, then groundwater nodes should be treated as x-y locations and FACT should be set to 0.0. If input data is based on node numbers, the spaces reserved for x and y coordinates must be left blank. NOUTH must be set to zero if no groundwater hydrographs are required. To print the average head for all layers, IOUTHL is set to zero. If hydrographs at a layer other than the top most layer are desired, then enter the layer number and the node number at the top most layer. For instance, to print hydrographs at node 35 at layers 1 and 2 specify two entries: (i) IOUTHL = 1 and IOUTH = 35 and (ii) IOUTHL = 2 and

IOUTH = 35. The procedure is the same if hydrographs at multiple layers at an x-y location are desired.

Next, the number of stream hydrographs (NOUTR), stream hydrograph output values (IHSQR) and stream node numbers must be specified. The stream hydrographs can represent stream flows (IHSQR=0) or stream surface elevations (IHSQR=1). If no stream hydrographs are required, then NOUTR must be set to zero.

To print out tile drain/subsurface irrigation hydrographs number of required hydrographs (NOUTTD) and the corresponding groundwater node numbers (IOUTTD) should be specified. If no tile drain/subsurface irrigation hydrographs are required, NOUTTD should be set to zero.

For boundary node flow printing, number of hydrographs (NOUTB) and corresponding groundwater boundary node (IOUTB) and layer number (IOUTBL) should be specified. The nodes for which flow printing are requested should be specified boundary conditions in file Unit 8.

To print out the flow rates at element faces, number of element faces (NOUTF) for print-out, the aquifer layer numbers in which the element faces is located (IOUTFL), and the node numbers that identify each of the element faces (IOUTFA and IOUTFB) should be specified.

The following variables are located in this input file for the purposes of specifying hydrograph printing options:

NOUTH	Total number of groundwater hydrographs to be printed; set NOUTH = 0 if no groundwater hydrograph data is to be printed

FACT	Factor to convert nodal coordinates into simulation unit of length. If FACT = 0.0 the input data is by nodes; if FACT > 0.0 the input data is by x-y coordinates
IOUTHL	Layer number (IOUTHL = 0 to print average head for all layers)
X	The x-coordinate of the well location (specify only if FACT > 0.0), [L]
Y	The y-coordinate of the well location (specify only if FACT > 0.0), [L]
IOUTH	Groundwater node number (specify only if FACT = 0.0)
NOUTR	Total number of stream hydrographs to be printed; NOUTR = 0 if no stream hydrograph data is to be printed
IHSQR	Switch for the output of stream surface elevations or stream flows; IHSQR = 0 if output of stream flows is desired, IHSQR = 1 if output of stream surface elevations is desired
IOUTR	Stream node number for printing hydrograph output
NOUTTD	Total number of tile drain/subsurface irrigation hydrographs to be printed; NOUTTD = 0 if no tile drain/subsurface irrigation hydrograph is to be printed
IOUTTD	Groundwater node number corresponding to the tile drain/subsurface irrigation location for hydrograph printing

NOUTB	Total number of flow hydrographs at boundary nodes to be printed; NOUTB = 0 if no hydrographs at boundary nodes are to be printed
IOUTBL	Layer number of the groundwater boundary node for hydrograph printing
IOUTB	Groundwater node number for boundary node hydrograph printing
NOUTF	Number of element faces for flow printing
IOUTFL	Aquifer layer number that an element face is located
IOUTFA	The first groundwater node number that defines the element face
IOUTFB	The second groundwater node number that defines the element face

```
C*******************************************************************************
C
C                  INTEGRATED WATER FLOW MODEL (IWFM)
C                        *** Version ### ***
C
C*******************************************************************************
C
C                    PRINT CONTROL DATA FILE
C                      for IWFM Simulation
C                           (Unit 10)
C
C
C             Project:  IWFM Version ### Release
C                       California Department of Water Resources
C             Filename: PRINT.DAT
C
C*******************************************************************************
C                             File Description:
C
C   This data file contains the print output control data including a list of
C   the groundwater, stream and tile drain nodes for which hydrographs will be
C   printed,and a list of the boundary nodes for which groudwater flow will be
C   printed.
C
C*******************************************************************************
C           Groundwater Hydrograph Print Control Specifications
C
C   The following lists the node and layer numbers for which groundwater
C   hydrograph will be printed
C
C   NOUTH;   Total number of hydrographs to be printed
C              (set NOUTH = 0 if no hydrograph data is to be printed)
C   FACT ;   Conversion factor for nodal coordinates
C             If FACT = 0.0 the input data is by nodes
C             If FACT > 0.0 the input data is by X-Y coordinates
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C
    7                           / NOUTH
    0.0                         / FACT
C-------------------------------------------------------------------------------
C
C   The following lists the layer number and groundwater node number for
C   each groundwater hydrograph to be printed (skip if no hydrographs are
C   to be printed, ie. NOUTH = 0)
C
C   IOUTHL;  Layer number (IOUTHL = 0 to print average head for all layers)
C   X     ;  The x-coordinate of the  well location (specify ONLY if FACT > 0.0); [L]
C   Y     ;  The y-coordinate of the  well location (specify ONLY if FACT > 0.0); [L]
C   IOUTH ;  Groundwater node number (specify ONLY if FACT = 0.0)
C
C-------------------------------------------------------------------------------
C       IOUTHL         X           Y            IOUTH
C-------------------------------------------------------------------------------
          1                                     433
          1                                     412
          1                                     391
          2                                     76
          2                                     55
          2                                     34
          2                                     13
C-------------------------------------------------------------------------------
C*******************************************************************************
C               Stream Hydrograph Print Control Specifications
C
C   NOUTR;   Total number of hydrographs to be printed
C             (NOUTR = 0 if no stream hydrograph data is to be printed)
C   IHSQR;   Switch for the output of stream surface elevations or stream flows;
C             IHSQR = 0 if output of stream flows is desired,
C             IHSQR = 1 if output of stream surface elevations is desired
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
      23                        / NOUTR
      0                         / IHSQR
C-------------------------------------------------------------------------------
C
C   The following lists the stream node number for hydrograph to be printed
C   (skip if no hydrographs are to be printed, ie. NOUTR = 0)
C
C   IOUTR;   Stream node number for printing hydrograph output
C-------------------------------------------------------------------------------
C         IOUTR
C-------------------------------------------------------------------------------
           1
           2
           3
           4
           5
           6
```

```
           7
           8
           9
           10
           11
           12
           13
           14
           15
           16
           17
           18
           19
           20
           21
           22
           23
C-------------------------------------------------------------------------------
C*******************************************************************************
C    Tile Drain/Subsurface Irrigation Hydrograph Print Control Specifications
C
C   NOUTTD;  Total number of tile drain/subsurfae irrigation hydrographs to be printed
C             (set NOUTTD = 0 if no hydrographs are to be printed)
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
      6                         / NOUTTD
C-------------------------------------------------------------------------------
C
C
C   The following lists the tile drain/subsurface irrigation node number (i.e.
C    corresponding groundwater node) for hydrograph to be printed.
C   (skip if no hydrographs are to be printed, ie. NOUTTD = 0)
C
C   IOUTTD;   Tile drain/subsurafe irrigation node number for printing hydrograph output
C-------------------------------------------------------------------------------
C         IOUTTD
C-------------------------------------------------------------------------------
           6
           69
           132
           195
           258
           321
C-------------------------------------------------------------------------------
C*******************************************************************************
C                          Boundary Node Flow Print Control
C
C   The following lists the boundary nodes and layers for which flow values
C     will be printed
C
C   NOUTB;   Total number of flow hydrographs to be printed (set NOUTB = 0
C             if no flow hydrographs are to be printed)
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
      6                         / NOUTB
C-------------------------------------------------------------------------------
C
C   The following lists the layer number and groundwater node number for
C   each flow hydrograph to be printed (skip if no flow hydrograph is
C   to be printed, ie. NOUTB = 0)
C
C   IOUTBL;  Layer number
C   IOUTB;   Groundwater node number for flow hydrograph output
C-------------------------------------------------------------------------------
C   IOUTBL          IOUTB
C-------------------------------------------------------------------------------
      1               1
      1              22
      1              85
      1             148
      1             211
      1             274
C*******************************************************************************
C                          Element Face Flow Print Control
C
C   The following lists the element faces for which the flow output is desired
C
C-------------------------------------------------------------------------------
C
C   NOUTF  ; Number of element faces for flow output
C
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
      3                         /NOUTF
C-------------------------------------------------------------------------------
C
C   The following lists the layer number and groundwater node numbers that
```

```
C   defines the element face for each face flow hydrograph to be printed (skip
C   if no element face flow hydrograph is to be printed, ie. NOUTFF = 0)
C
C   IOUTFL ; Layer number
C   IOUTFA ; The first groundwater node number that defines the element face
C   IOUTFB ; The second groundwater node number that defines the element face
C-------------------------------------------------------------------------------
C   IOUTFL     IOUTFA     IOUTFB
C-------------------------------------------------------------------------------
      1          89         90
      1          91         90
      2          91         90
```

Initial Conditions File Unit 11

This data file contains the initial aquifer head values for each node and layer, initial soil moisture conditions for root zone, unsaturated zone and small watersheds and initial lake surface elevations. It also includes initial interbed thickness and initial pre-consolidation head values for each layer if it is desired to overwrite the values set in parameter data file.

Initial Aquifer Head Values

Initial aquifer head values must be specified for all nodes in each aquifer layer modeled. If the initial groundwater head specified is below the bottom elevation of the aquifer layer, then IWFM sets it to the elevation of the bottom of the aquifer. The list below describes the input values to define the initial aquifer head values. All values are to be specified for each layer modeled in IWFM.

FACT	Conversion factor for initial heads
HP	Initial head at each groundwater node, [L]

Initial Soil Moisture Conditions

Initial soil moisture conditions are specified in this file for the root zone, unsaturated zone and small stream watersheds modeled. If the subregion number for initial root zone soil moisture, element number for initial unsaturated zone soil moisture or small watershed number is specified as zero, then the values specified are used for all subregions, elements or small watersheds, respectively. Initial root zone moisture can be

specified as volume or as a fraction of the average field capacity for each subregion and land use type. The following variables are used to input initial soil moisture conditions:

FACTSM	Conversion factor for volumetric initial root zone moisture; if initial root zone moisture is to be specified as a fraction of the root zone depth, then specify a value 0.0
ID	Subregion number for initial soil moisture in root zone or element number for initial soil moisture in unsaturated zone; specify as zero if the following initial moisture conditions are to be used for all subregions for initial root zone moisture or for all elements for initial unsaturated zone moisture
SOILM	Initial soil moisture as a volume or as a fraction of the field capacity for each subregion, land use type and soil group, [L^3] or [L/L] depending on the value of FATSM
FACT	Weighting factor for initial unsaturated zone soil moisture or conversion factor for initial groundwater storage for small watersheds
UNSATM	Initial soil moisture for each layer of the unsaturated zone as fraction of the total porosity given for the unsaturated layers, [L/L]
IS	Small stream watershed number; specify as zero if the values for SOILS and GWSTS are to be used for all small stream watersheds

SOILS	Initial soil moisture at the small watershed as a fraction of field capacity, [L/L]
GWSTS	Initial groundwater storage for each watershed, [L]

Initial Lake Elevations

Initial lake elevations are also listed in this file. This section should be skipped if there are no lakes being modeled. The following variables are required to be set:

FACT	Conversion factor for initial lake elevations
ILAKE	Sequential lake number
HLAKE	Initial lake elevation, [L]

Interbed Thickness for each Layer

All values are specified for each layer modeled in IWFM. Interbed thicknesses are used to compute land subsidence. This part of the data file is used if the initial interbed depths defined in Unit 7 are chosen to be overwritten. Skip this part of the data file if overwriting the already specified values is not desired.

FACT	Conversion factor for initial interbed thickness
DC	Initial interbed thicknesses at corresponding groundwater nodes, [L]

Pre-Consolidation Head values for Land Subsidence

All pre-consolidation head values are specified for each layer modeled in IWFM in the parameter file (Unit 7). This section of the initial conditions data file is used if pre-

consolidation heads specified previously are to be overwritten. This portion of the data file should be skipped if the pre-consolidation heads remain the same as specified in Unit 7.

FACT	Conversion factor for pre-consolidation head values
HC	Pre-consolidation head at corresponding groundwater node, [L]

```
C*******************************************************************************
C
C                  INTEGRATED WATER FLOW MODEL (IWFM)
C                        *** Version ### ***
C
C*******************************************************************************
C
C                  INITIAL CONDITIONS DATA FILE
C                      for IWFM Simulation
C                           (Unit 11)
C
C
C             Project:  IWFM Version ### Release
C                       California Department of Water Resources
C             Filename: INIT.DAT
C
C*******************************************************************************
C                         File Description
C
C   This data file contains the initial head at each groundwater node for
C   each aquifer (layer) modeled; the initial soil moisture values for root zone,
C   unsaturated zone and small watersheds; initial interbed thickness to overwrite
C   the values set in parameter data file; initial preconsolidation head values
C   that overwrite the values et in the parameter data file and initial lake
C   elevations.
C
C*******************************************************************************
C                       Initial Aquifer Head Values
C
C   FACT;  Conversion factor for initial heads
C   HP;    Initial head at corresponding groundwater node; [L]
C------------------------------------------------------------------------------
C   Layer 1:
C
C   VALUE                       DESCRIPTION
C------------------------------------------------------------------------------
     1.0                        / FACT
C------------------------------------------------------------------------------
C    Initial Head at Layer 1
C    HP
C------------------------------------------------------------------------------
  605.70    605.78    622.82    576.75    492.61    540.47    540.05    525.74    430.35    500.23
  387.98    535.68    770.63    720.75    419.39    432.54    378.50    665.61    715.66    720.67
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
  880.04   1715.75    671.79    495.93    495.62   2009.94    640.92    500.33    827.41   1347.38
 1006.64   1312.05   1412.70
C------------------------------------------------------------------------------
C   Layer 2
C
C   VALUE                       DESCRIPTION
C------------------------------------------------------------------------------
     1.0                        / FACT
C------------------------------------------------------------------------------
C    Initial Head at Layer 2
C    HP
C------------------------------------------------------------------------------
  555.45    593.96    620.51    575.32    493.74    538.18    538.10    481.44    432.95    498.63
  392.65    488.99    722.07    671.21    421.54    431.37    381.21    617.24    666.88    671.61
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
  724.00   1400.00    501.95    463.88    100.00   1800.00    561.68    500.90    600.00   1199.00
  876.00   1200.00   1300.00
C------------------------------------------------------------------------------
C   Layer 3
C
C   VALUE                       DESCRIPTION
C------------------------------------------------------------------------------
     1.0                        / FACT
C------------------------------------------------------------------------------
C    Initial Head at Layer 3
C    HP
C------------------------------------------------------------------------------
  555.00    555.00    555.00    415.00    496.26    532.91    415.00    475.00    439.00    495.00
  270.00    485.00    720.00    670.00    426.60    428.75    387.56    615.00    665.00    541.45
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
  445.25   1400.00    497.86    462.46    451.16   1800.00    557.20    502.77    600.00   1199.00
  876.00   1200.00   1300.00
C------------------------------------------------------------------------------
C*******************************************************************************
C                         Initial Soil Moisture Conditions
C
C   Following are the initial soil moisture conditions for the root zone, the
C   unsaturated zone, and the small watersheds in the model. These set of data
C   need to be provided only if there is at least one rain gage that is specified
C   in Pre-processor. Skip if no rain gage is specified.
```

```
C
C-------------------------------------------------------------------------------
C                          Initial Soil Moisture Condition
C                                For Root Zone
C
C   FACTSM;     Conversion factor for volumetric initial root zone moisture
C                (enter 0.0 if initial moisture condition is given as a
C                 dimensionless quantity)
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
     1.0                        / FACTSM
C-------------------------------------------------------------------------------
C
C   ID   ;   Subregion No. (0 if following values are to be used for all subregions)
C   SOILM;   Initial root zone moisture for corresponding land use type
C              for each soil group; [L^3] or [L/L]
C
C-------------------------------------------------------------------------------
C                                  Land use type
C           ---------------------------------------------------------------------
C    ID           Ag.          Urban          Native Veg.    Riparian Veg.
C-------------------------------------------------------------------------------
     0            0.0          0.0            0.0            0.0
                  0.0          0.0            0.0            0.0
                  0.0          0.0            0.0            0.0
                  0.0          0.0            0.0            0.0
C*******************************************************************************
C                          Initial Soil Moisture Condition
C                               For Unsaturated Zone
C
C   FACT;    Weighting factor for initial unsaturated zone soil moisture
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
     1.0                        / FACT
C-------------------------------------------------------------------------------
C
C   ID    ;  Element No. (0, if following values are to be used for all elements)
C   UNSATM;  Initial soil moisture content for each layer of the
C             unsaturated zone [L/L]
C-------------------------------------------------------------------------------
C                            Unsaturated Layers
C         ---------------------------------------------------------------
C  ID             1           2   ......
C-------------------------------------------------------------------------------
    0              0.0         0.0
C*******************************************************************************
C                          Initial Soil Moisture Conditions
C                               For Small Watersheds
C
C   FACT;  Conversion factor for initial groundwater storage for each of the
C            small watershed
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
     1.0                        / FACT
C-------------------------------------------------------------------------------
C
C   IS   ;   Watershed No (0, if following values are to be used for all watersheds)
C   SOILS;   Initial soil moisture content for for each watershed; [L/L]
C   GWSTS;   Initial groundwater storage for each watershed; [L]
C-------------------------------------------------------------------------------
C     IS              SOILS                  GWSTS
C-------------------------------------------------------------------------------
       0               0.0                   10.0
C-------------------------------------------------------------------------------
C*******************************************************************************
C                     Initial Lake Elevations
C                (Skip if there are no lakes simulated)
C
C   FACT ;  Conversion factor for initial lake elevations
C   ILAKE;  Sequential lake number
C   HLAKE;  Initial lake elevations; [L]
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
      1.0                       /FACT
C-------------------------------------------------------------------------------
C    ILAKE     HLAKE
C-------------------------------------------------------------------------------
       1       280.0
C-------------------------------------------------------------------------------
C*******************************************************************************
C                    Interbed Thickness for Each Layer
C
C   The following lists the initial Interbed Thicknesses for each node (in
C   sequential order) to overwrite what is specified in the parameter file.
C
C   FACT;   Conversion factor for initial interbed thickness
```

```
C   DC  ;   Initial interbed thickness; [L]
C-------------------------------------------------------------------------------------------------
C   Layer 1:
C
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------------------------
     1.0                        / FACT
C-----------------------------------------------------------------------
C    Initial interbed thickness at Layer 1
C    DC
C-----------------------------------------------------------------------
   13.00     12.00     12.00     12.00     12.00     19.00     12.00      7.00     14.00     11.00
   22.00     26.00     23.00      8.00      8.00     13.00     23.00     10.00      8.00      8.00
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
   17.00     33.00    101.00    104.00    105.00     42.00     84.00     85.00     81.00     65.00
   65.00     63.00     63.00
C-----------------------------------------------------------------------
C    Layer 2:
C
C    VALUE                       DESCRIPTION
C-----------------------------------------------------------------------
     1.0                        / FACT
C-----------------------------------------------------------------------
C    Initial interbed thickness at Layer 2
C    DC
C-----------------------------------------------------------------------
    4.00      4.00      4.00      5.00      4.00      3.00      4.00      4.00      4.00      3.00
    5.00      5.00      5.00      5.00      5.00      4.00      5.00      4.00      5.00      5.00
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
   35.00      0.00    135.00    132.00      0.00      0.00    129.00    131.00      0.00      0.00
    0.00      0.00      0.00
C-----------------------------------------------------------------------
C   Layer 3
C
C   VALUE                       DESCRIPTION
C-----------------------------------------------------------------------
      1.0                       /FACT
C -----------------------------------------------------------------------
C    Interbed Thickness for Layer 3
C    DC
C-----------------------------------------------------------------------
    0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
    0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
    0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
    0.00      0.00      0.00
C-----------------------------------------------------------------------
C***********************************************************************
C             Initial Preconsolidation Head Values for Land Subsidence
C
C   The following lists the preconsolidation head for each groundwater node
C   (in sequential order) to overwrite the values specified in parameter file.
C
C   FACT;    Conversion factor for preconsolidation head
C   HC  ;    Initial preconsolidation head at corresponding groundwater node; [L]
C
C-----------------------------------------------------------------------
C   Layer 1
C
C   VALUE                       DESCRIPTION
C-----------------------------------------------------------------------
      1.0                       /FACT
C-----------------------------------------------------------------------
C    Initial preconsolidation head at Layer 1
C    HC
C-----------------------------------------------------------------------
  506.00    506.00    523.00    477.00    393.00    440.00    440.00    426.00    330.00    400.00
  288.00    436.00    671.00    621.00    319.00    333.00    279.00    566.00    616.00    621.00
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
  750.00    750.00    672.00    496.00    340.00    510.00    641.00    500.00    750.00    750.00
  750.00    750.00    750.00
C-----------------------------------------------------------------------
C   Layer 2
C
C   VALUE                       DESCRIPTION
C-----------------------------------------------------------------------
      1.0                       /FACT
C-----------------------------------------------------------------------
C    Initial preconsolidation head at Layer 2
C    HC
C-----------------------------------------------------------------------
  455.00    494.00    521.00    475.00    394.00    438.00    438.00    381.00    333.00    399.00
```

```
  293.00    389.00    622.00    571.00    322.00    331.00    281.00    517.00    567.00    572.00
      .         .         .         .         .         .         .         .         .         .
      .         .         .         .         .         .         .         .         .         .
      .         .         .         .         .         .         .         .         .         .
  407.00    750.00    452.00    414.00    340.00    750.00    522.00    451.00    506.00    750.00
  750.00    750.00    750.00
C-------------------------------------------------------------------------------
C   Layer 3
C
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
      1.0                       /FACT
C-------------------------------------------------------------------------------
C    Preconsolidation Head at Layer 3
C    HC
C-------------------------------------------------------------------------------
  412.00    488.00    515.00    472.00    396.00    433.00    434.00    378.00    339.00    395.00
  303.00    384.00    585.00    431.00    327.00    329.00    288.00    370.00    488.00    441.00
      .         .         .         .         .         .         .         .         .         .
      .         .         .         .         .         .         .         .         .         .
      .         .         .         .         .         .         .         .         .         .
  445.00    546.00    498.00    462.00    340.00    563.00    557.00    503.00    521.00    750.00
  750.00    750.00    750.00
```

Supply Adjustment Specifications File Unit 12

This data file contains the time series specifications for the adjustment of surface water diversions and groundwater pumping in order to minimize the discrepancy between the agricultural and urban water demand and water supply. The data contains information to specify if a diversion or pumping should be adjusted to meet agricultural demand, urban demand or both. Each diversion or pumping scheme is associated with a column in this file through the surface water diversion specification file (Unit 25) or through the pumping specification file (Unit 23). This file is required when KOPTDV is set to a value other than 00 in the main input file (Unit 5).

The following variables are required to be set:

NCOLADJ	Number of columns in the supply adjustment specifications data file
NSPADJ	Number of time step to update the supply adjustment specifications data
NFQADJ	Repetition frequency of the supply adjustment specifications data (enter zero if full time series data is supplied)
ITADJ	Time (defined for the convenience of the user; it is not used in IWFM internally)
KADJ	Supply adjustment option specified as a two digit number; first digit from left specifies if the water supply (diversion or pumping) is to be adjusted to meet agricultural supply

requirement (0 = no adjustment is required; 1 = adjust water supply to meet agricultural water requirement); second digit from left specifies if the water supply (diversion or pumping) is to be adjusted to meet urban supply requirement (0 = no adjustment is required; 1 = adjust water supply to meet urban supply requirement)

```
C*******************************************************************************
C
C                  INTEGRATED WATER FLOW MODEL (IWFM)
C                        *** Version ### ***
C
C*******************************************************************************
C
C                     SUPPLY ADJUSTMENT SPECIFICATIONS
C                           for IWFM Simulation
C                                (Unit 12)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  SUPPLYADJ.DAT
C
C*******************************************************************************
C                           File Description
C
C   This data file contains the time series specifications for the adjustment of
C   surface water diversions and groundwater pumping. The data contains information
C   to specify if a diversion or pumping should be adjusted to meet agricultural
C   demand, urban demand or both. This file is required when KOPTDV is set to a
C   value other than 00 in the main input file (Unit 5).
C
C*******************************************************************************
C                     Supply Adjustment Specifications
C
C   The following lists the time-series specifications for supply adjustment options
C   for surface water diversions and groundwater pumping.
C
C   NCOLADJ;  Number of columns in the supply adjustment specifications data file
C   NSPADJ ;  Number of time steps to update the supply adjustment specifications data
C   NFQADJ ;  Repetition frequency of the supply adjustment specifications data
C             (enter 0 if full time series data is supplied)
C
C-------------------------------------------------------------------------------
C   VALUE                 DESCRIPTION
C-------------------------------------------------------------------------------
     10                    /NCOLADJ
     30                    /NSPADJ
     0                     /NFQADJ
C*******************************************************************************
C
C                           Specifications Data
C
C   ITADJ;  Time
C   KADJ;   Supply adjustment option. Enter two digits as follows:
C           1st digit(from left):
C                 0 = NO adjustment of supply to meet agricultural water demand
C                 1 = YES, adjust supply to meet agricultural water demand
C           2nd digit(from left):
C                 0 = NO adjustment of supply to meet urban water demand
C                 1 = YES, adjust supply to meet urban water demand
C
C-------------------------------------------------------------------------------
C   ITADJ       KADJ
C-------------------------------------------------------------------------------
C          1      2       3       4 ......
     1    11     11      01      11      10      10      01      01      11      11
    31    11     11      11      00      11      10      01      01      11      11
     .     .      .       .       .       .       .       .       .       .       .
     .     .      .       .       .       .       .       .       .       .       .
     .     .      .       .       .       .       .       .       .       .       .
  2941    11     11      01      00      11      10      10      11      11      10
  2971    11     11      01      00      11      10      10      11      11      10
```

Land Use Data File Unit 13

The land use data file specifies the area (or fraction of area relative to the total elemental area) associated with each land use type within an element. The four land use types modeled in IWFM are agricultural, urban, native and riparian lands. Elemental areas must be specified for each land use type at all specified time steps. If a land use type does not exist within an element, define the area as zero. Similarly, if the user does not want to model a specified land use type, the area should be entered as zero for all elements. A pre-processor is available that interpolates and extrapolates survey year land use areas given that a complete time-series data set of subregional areas is provided.

The factor to convert land use areas to the simulation unit of area, the number of time steps to update the data, and the repetition frequency of the data file must be specified in this file. This information is followed by the value that represents the time (ITLN), as well as all elements and the land use areas within each element. The time series data set can be represented by any frequency, as long as the correct time step controls are set (NSPLN and NFQLN) and they correspond to the time step controls set in crop acreage data file (Unit 14). The input to Unit 13 is as follows:

FACTLN	Conversion factor for land use area; a value of 0.0 should be entered when land use areas are specified as a fraction of the total elemental area
NSPLN	Number of time steps to update the land use data; the value must equal the number of time steps to update the crop acreage data file (NSPCR in Unit 14)

NFQLN	Repetition frequency of the land use data; NFQLN must equal NFQCR specified in Unit 14 and NFQLN is set to zero for a time series data file that includes the entire simulation period
ITLN	Time (defined for the convenience of the user; it is not used in IWFM internally)
IE	Element identification number
ALAND	Area corresponding to each land use type (agricultural, urban, native vegetation and riparian vegetation) over an element, [L^2]

```
C*******************************************************************************
C
C              INTEGRATED WATER FLOW MODEL (IWFM)
C                     *** Version ### ***
C
C*******************************************************************************
C
C                    LAND USE DATA FILE
C                   for IWFM Simulation
C                        (Unit 13)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  LANDUSE.DAT
C
C*******************************************************************************
C                          File Description
C
C   This data file contains the land use distribution for each element
C   for the simulation period.
C
C*******************************************************************************
C                           Land use data
C
C   FACTLN;   Conversion factor for land use area
C              (enter 0.0 if land use distribution is given as a
C               fraction of element area)
C   NSPLN ;   Number of time steps to update the land use data
C              (Note: This value should be equal to NSPCR in crop acreage data file)
C   NFQLN ;   Repetition frequency of the land use data
C              (enter 0 if full time series data is supplied)
C              (Note: This value should be equal to NFQCR in crop acreage data file)
C
C------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C------------------------------------------------------------------------------
    43560.0                    / FACTLN
    3600                       / NSPLN
    0                          / NFQLN
C------------------------------------------------------------------------------
C
C   The following lists the land use area for each element.
C
C   ITLN ;   Time
C   IE   ;   Element number
C   ALAND;   Area (or fraction of area) corresponding to each land use type
C             over an element; [L^2] or [L/L]
C
C-------------------------------------------------------------------------------
C                                          ALAND
C                        ------------------------------------------------------
C   ITLN    IE       Agricultural    Urban     Native veg.      Riparian veg.
C-------------------------------------------------------------------------------
     1      1        91.83           0.00      0.00             0.00
            2        91.83           0.00      0.00             0.00
            3        91.83           0.00      0.00             0.00
            .        .               .         .                .
            .        .               .         .                .
            .        .               .         .                .
            398      0.00            0.00      0.00             91.83
            399      0.00            0.00      0.00             91.83
            400      0.00            0.00      0.00             91.83
```

Crop Acreage Data File Unit 14

This file contains the time series subregional acreages for all crops modeled as well as non-agricultural land use types in the modeled area. This includes urban, native, and riparian areas which are the last three listed for each time step. The sum of all crop and non-agricultural land use type areas given for a subregion should equal the subregional area specified in the model. For each time step specified, all subregional crop and non-agricultural areas are specified. The time series data set can be comprised of any frequency, as long as the correct time step controls are set (NSPCR and NFQCR) and they correspond to the time step controls set in Unit 13. The following terms and descriptions encompass the data input to Unit 14:

NCOLCR	Total number of crops and non-agricultural land use types modeled
FACTCR	Factor to convert crop area to simulation unit of area
NSPCR	Number of time steps to update the subregional acreage data; NSPCR must equal the value specified for NSPLN in Unit 13
NFQCR	Repetition frequency of the subregional acreage data; NFQCR must equal NFQLN specified in Unit 13. NFQLN is set to zero when this file includes a time-series data defined for the entire simulation period
ITCR	Time (defined for the convenience of the user; it is not used in IWFM internally)

IR	Subregion identification number
ACROP	Area of crop and land use types within each subregion, [L^2]

```
C*******************************************************************************
C
C               INTEGRATED WATER FLOW MODEL (IWFM)
C                     *** Version ### ***
C
C*******************************************************************************
C
C                  CROP ACREAGE DATA FILE
C                   for IWFM Simulation
C                        (Unit 14)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  CROPAREA.DAT
C
C*******************************************************************************
C                        File Description:
C
C   This data file contains the time-series crop acreage data for each sub-region.
C
C*******************************************************************************
C                        Crop Acreage Data Specifications
C
C   NCOLCR;  Total number of crop and non-agricultural land use types
C   FACTCR;  Conversion factor for crop area
C   NSPCR ;  Number of time steps to update the crop acreage data
C             (Note: This value should be equal to NSPLN in land use data file)
C   NFQCR ;  Repetition frequency of the crop acreage data
C             (enter 0 if full time series data is supplied)
C             (Note: This value should be equal to NFQLN in land use data file)
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
    5                           / NCOLCR
    43560.0                     / FACTCR
    3600                        / NSPCR
    0                           / NFQCR
C-------------------------------------------------------------------------------
C                        Crop Acreage Data
C
C   The following lists the acreage for each crop and non-agricultural land use
C   type for each sub-region for model simulation
C
C   ITCR ;   Time of crop survey
C   IR   ;   Subregion number
C   ACROP;   Acreage of crop or land use type in corresponding sub-region; [L^2]
*
*   Crop/Land Use No.           Name
*   -----------------           ------
*         1                PA = PASTURE
*         2                AL = ALFALFA
*         3                UR = URBAN
*         4                NV = NATIVE VEGETATION
*         5                RV = RIPARIAN VEGETATION
C-------------------------------------------------------------------------------
C ITCR  IR   ACROP(1)  ACROP(2)  ACROP(3)  ACROP(4)  ACROP(5)
C-------------------------------------------------------------------------------
  1    1     8723.59    9090.91     0.00      550.98       0.00
       2        0.00       0.00  8815.42     4958.69    4591.37
```

Precipitation File Unit 15

This file contains the time series rainfall values for each of the rainfall stations used in the simulation. Each element is associated with a rainfall station. The factors that convert the precipitation at rainfall stations to the precipitation over the elements are listed in the element characteristic input file in pre-processor. The rainfall data for a station associated with an element is multiplied by the factor defined in the pre-processor to obtain the rainfall rate over an element.

A time-series precipitation data set of any frequency can be used as the precipitation data in IWFM. NSPRN and NFQRN must be specified according to the frequency of the data entered. If the precipitation data is specified for the entire simulation period, NFQRN should be set to zero. The following variables are used:

NRAIN	Number of rainfall stations used in the model
FACTRN	Conversion factor for rainfall rate
NSPRN	Number of time steps to update the precipitation data
NFQRN	Repetition frequency of the precipitation data (enter zero if full time series data is supplied)
ITRN	Time (defined for the convenience of the user; it is not used in IWFM internally)
ARAIN	Rainfall rate at the corresponding rainfall station, [L/T]

```
C*******************************************************************************
C
C               INTEGRATED WATER FLOW MODEL (IWFM)
C                     *** Version ### ***
C
C*******************************************************************************
C
C                  PRECIPITATION DATA FILE
C                    for IWFM Simulation
C                        (Unit 15)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  PRECIP.DAT
C
C*******************************************************************************
C                            File Description:
C
C   This data file contains the time-series rainfall at each rainfall station used
C   in the model.
C*******************************************************************************
C                           Rainfall Data Specifications
C
C   NRAIN ;  Number of rainfall stations used in the model
C   FACTRN;  Conversion factor for rainfall rate
C   NSPRN ;  Number of time steps to update the precipitation data
C   NFQRN ;  Repetition frequency of the precipitation data
C             (enter 0 if full time series data is supplied)
C
C------------------------------------------------------------------------------
C   VALUE                          DESCRIPTION
C------------------------------------------------------------------------------
    2                              / NRAIN
    0.0027778                      / FACTRN
    30                             / NSPRN
    12                             / NFQRN
C------------------------------------------------------------------------------
C                           Rainfall Data
C
C   The following lists the rainfall at each rainfall station for the model
C   simulation period.
C
C   ITRN ;   Time
C   ARAIN;   Rainfall rate at the corresponding rainfall station; [L/T]
C------------------------------------------------------------------------------
C ITRN    ARAIN(1)  ARAIN(2)  ARAIN(3) ...
C------------------------------------------------------------------------------
    1        2.0       1.0
    2        4.0       2.0
    3        6.0       3.0
    4        5.0       2.5
    5        50.0      25.0
    6        70.0      35.0
    7        80.0      40.0
    8        4.0       2.0
    9        1.0       0.5
   10        5.0       2.5
   11        0.0       0.0
   12        0.0       0.0
```

Evapotranspiration File Unit 16

The evapotranspiration data file contains time series ET_c data for all crop types, non-agricultural land use types and bare soil evaporation under standard conditions for each subregion. The ET_c rates should be entered in the following order: agricultural crop types in the order listed in the parameter data file (Unit 7), urban, native vegetation, riparian vegetation and bare soil evaporation. This is followed by ET_c and soil evaporation for each small stream watershed group specified in the parameter data file (Unit 7). The conversion factor for the ET_c rates is a required input, as well as the number of time steps to update the data and the repetition frequency of the data. The following a list of the variables that need to be specified:

NEVAP	Number of crop and land use types
FACTET	Conversion factor for evapotranspiration rate
NSPET	Number of time steps to update the ET data
NFQET	Repetition frequency of the ET data (enter zero if full time series data is supplied)
ITEV	Time (defined for the convenience of the user; it is not used in IWFM internally)
IREGN	Subregion number
AEVAP	Evapotranspiration rate for all crop types, non-agricultural land use types and bare soil evaporation under standard conditions in a subregion, [L/T]. After listing ET rates for each subregion, the ET_c rates for native vegetation and soil

evaporation for each small watershed group should also be listed

```
C*******************************************************************************
C
C                  INTEGRATED WATER FLOW MODEL (IWFM)
C                        *** Version ### ***
C
C*******************************************************************************
C
C                    EVAPOTRANSPIRATION DATA FILE
C                        for IWFM Simulation
C                             (Unit 16)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  ET.DAT
C
C*******************************************************************************
C                         File Description:
C
C   This data file contains the crop evapotranspiration values under standard
C   conditions (ETc) for each sub-region for each crop and non-agricultural land
C   use type. Evapotranspiration rate of native vegetation and soil at small stream
C   watersheds are also listed in this file.
C
C*******************************************************************************
C                       Evapotranspiration Data Specifications
C
C   NEVAP ;  Number of crop and land use types
C   FACTET:  Conversion factor for evapotranspiration rate
C   NSPET ;  Number of time steps to update the ET data
C   NFQET ;  Repetition frequency of the ET data
C             (enter 0 if full time series data is supplied)
C
C-------------------------------------------------------------------------------
C   VALUE                          DESCRIPTION
C-------------------------------------------------------------------------------
    6                              / NEVAP
    0.00277778                     / FACTET
    30                             / NSPET
    12                             / NFQET
C-------------------------------------------------------------------------------
C                       Evapotranspiration Data
C
C   The following is a list of the evapotranspiration rate of each crop
C   non-agricultural land use, and soil under standard conditions, for each
C   sub-region. This is followed by the ETc rate for native vegetation and soil
C   for small stream watersheds.
C
C   ITEV ;   Time
C   IREGN;   Subregion number
C   AEVAP;   Evapotranspiration rate for corresponding land use and sub-region; [L/T]
C             (Include ETc rates for all crop types, non-agricultural land use types and
C              soil evaporation. After listing ETc values for each subregion, list the values
C              for native vegetation and soil evaporation for small stream watersheds.)
C-------------------------------------------------------------------------------
C ITEV  IREGN  AEVAP(1)  AEVAP(2)  AEVAP(3) ...
C-------------------------------------------------------------------------------
   10     1   3.0     3.5     3.5    3.5    3.5    3.5
          2   3.0     3.5     3.5    3.5    3.5    3.5
          1   3.0     3.5
          2   3.0     3.5
   11     1   3.0     3.5     3.5    3.5    3.5    3.5
          2   3.0     3.5     3.5    3.5    3.5    3.5
          1   3.0     3.5
          2   3.0     3.5
    .     .     .       .       .      .      .      .
          .     .       .       .      .      .      .
          .     .       .       .      .      .      .
          .     .       .       .      .      .      .
    .     .     .       .       .      .      .      .
          .     .       .       .      .      .      .
          .     .       .       .      .      .      .
          .     .       .       .      .      .      .

    8     1   3.0     3.5     3.5    3.5    3.5    3.5
          2   3.0     3.5     3.5    3.5    3.5    3.5
          1   3.0     3.5
          2   3.0     3.5
    9     1   3.0     3.5     3.5    3.5    3.5    3.5
          2   3.0     3.5     3.5    3.5    3.5    3.5
          1   3.0     3.5
          2   3.0     3.5
```

Tile Drain Parameter File Unit 17

This data file includes all the required input to model tile drains in IWFM. The start of the data file lists the number of groundwater nodes with tile drains, and conversion factors for tile drain elevations and conductance. Next, the actual table describing the tile drains is listed. For each node specified for tile drainage modeling, the elevation of the drain, conductance and stream node the drain flows into are required. If the tile drain flows leave the modeled area, the stream node should be set to zero.

The node number has a factor added to the actual node to indicate if a tile drain or a subsurface irrigation is being modeled. If a tile drain is being modeled, then 10000 is added to the corresponding groundwater node number and the resulting value is multiplied by –1. For example:

GW node = 543	GW node = 2004
Tile drain ID = –10543	Tile drain ID = –12004

For subsurface irrigation, 10000 is added to the corresponding groundwater node. For example:

GW node = 543	GW node = 2004
Subsurface irrigation ID = 10543	Subsurface irrigation ID = 12004

The following list includes all required input to simulate tile drain flows in IWFM:

NTD	Number of groundwater nodes with tile drains/subsurface irrigation
FACTH	Conversion factor for tile drain/subsurface irrigation elevations
FACTCDC	Conversion factor for tile drain/subsurface irrigation conductance

NODEDR	Node number corresponding to the tile drain/subsurface irrigation
ELEVDR	Elevation of the tile drain/subsurface irrigation, [L]
CDCDR	Hydraulic conductance of the interface between the aquifer and the tile drain/subsurface irrigation, [L^2/T]
ISTRMDR	Stream node into which drain flows into; 0 if the drain flows leave the modeled area

```
C*******************************************************************************
C
C                  INTEGRATED WATER FLOW MODEL (IWFM)
C                        *** Version ### ***
C
C*******************************************************************************
C
C                  TILE DRAINS PARAMETER DATA FILE
C                        for IWFM Simulation
C                            (Unit 17)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  TILEDRN.DAT
C
C*******************************************************************************
C                          File Description:
C
C   This data file contains tile drains parameter values.
C
C*******************************************************************************
C              Tile Drains Data Specifications
C
C   NTD    ;  Number of groundwater nodes with tile drains
C   FACTH  ;  Conversion factor for tile drain elevations
C   FACTCDC;  Conversion factor for tile drain conductances
C-------------------------------------------------------------------------------
C       VALUE                   DESCRIPTION
C-------------------------------------------------------------------------------
        21                      / NTD
        1.0                     / FACTH
        4.0                     / FACTCDC
C-------------------------------------------------------------------------------
C                     Tile Drain Parameters
C
C   The following lists the groundwater node number, elevation and conductance
C   for each tile drain. The stream node that the tile drain flow contributes to
C   is also listed.
C
C   NODEDR ; Groundwater node number corresponding to the tile drain
C        Case 1: For drainage out of node add -10000 to node number. For example,
C          list node 898 as -10898,
C          list node 98 as -10098,
C          list node 1898 as -11898
C        Case 2: For drainage into the node add 10000 to node number. For example,
C          list node 898 as 10898,
C          list node 98 as 10098,
C          list node 1898 as 11898
C   ELEVDR ; Elevation of the drain; [L]
C   CDCDR  ; Hydraulic conductance of the interface between the aquifer and
C             the drain; [L^2/T]
C   ISTRMDR; Stream node into which drain flows into (input 0 (zero) if the
C             drain flows out of the modeled area)
C
C-------------------------------------------------------------------------------
C   NODEDR    ELEVDR         CDCDR          ISTRMDR
C-------------------------------------------------------------------------------
     -10006     280.0         5000.0         20
     -10027     280.0         5000.0         20
     -10048     280.0         5000.0         20
     -10069     280.0         5000.0         20
     -10090     280.0         5000.0         20
     -10111     280.0         5000.0         20
     -10132     280.0         5000.0         20
     -10153     280.0         5000.0         20
     -10174     280.0         5000.0         20
     -10195     280.0         5000.0         20
     -10216     280.0         5000.0         20
     -10237     280.0         5000.0         20
     -10258     280.0         5000.0         20
     -10279     280.0         5000.0         20
     -10300     280.0         5000.0         20
     -10321     280.0         5000.0         20
     -10342     280.0         5000.0         20
     -10363     280.0         5000.0         20
     -10384     280.0         5000.0         20
     -10405     280.0         5000.0         20
     -10426     280.0         5000.0         20
```

Urban Water Use Specification File Unit 18

The urban water use file lists the fraction of water supplied to urban areas to be used indoors for each subregion. The following is a list of the variables used in this file:

NSPURBSP	Number of time steps to update the urban water use specification data
NFQURBSP	Repetition frequency of the urban water use specification data (enter zero if full time series data is supplied)
ITUSP	Time (defined for the convenience of the user; it is not used in IWFM internally)
IR	Subregion number
URINDR	Fraction of total urban water that is specified for urban indoor water use

```
C*******************************************************************************
C
C                  INTEGRATED WATER FLOW MODEL (IWFM)
C                        *** Version ### ***
C
C*******************************************************************************
C
C                  URBAN WATER USAGE SPECIFICATION DATA FILE
C                           for IWFM Simulation
C                               (Unit 18)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  URBSPEC.DAT
C
C*******************************************************************************
C                              File Description
C
C   This data file contains the urban water usage specification data. The
C   fraction of total urban water that is used indoors for each subregion
C   is listed.
C
C*******************************************************************************
C                             Urban Water Use Data Specifications
C
C   NSPURBSP;   Number of time steps to update the urban water use specification data
C   NFQURBSP;   Repitition frequency of the urban water use specification data
C                (enter 0 if full time series data is supplied)
C
C-------------------------------------------------------------------------------
C   VALUE                          DESCRIPTION
C-------------------------------------------------------------------------------
     30                            / NSPURBSP
     12                            / NFQURBSP
C-------------------------------------------------------------------------------
C                             Urban Water Use Data
C
C  ITUSP ;  Time
C  IR    ;  Subregion number
C  URINDR;  Fraction of total urban water that is used indoors
C
C-------------------------------------------------------------------------------
C  ITUSP    IR    URINDR
C-------------------------------------------------------------------------------
    1          1      0.7
               2      0.7
    2          1      0.7
               2      0.7
    3          1      0.7
               2      0.7
    4          1      0.7
               2      0.7
    5          1      0.7
               2      0.7
    6          1      0.7
               2      0.7
    7          1      0.7
               2      0.7
    8          1      0.7
               2      0.7
    9          1      0.7
               2      0.7
    10         1      0.7
               2      0.7
    11         1      0.7
               2      0.7
    12         1      0.7
               2      0.7
```

Agricultural Water Supply Requirement File Unit 19

This data file contains the water demand for the agricultural crops. The model requires that either this input file or Unit 22 is specified to simulate agricultural demand. Specifying this KOPTDM as zero in Unit 5 prompts the model to specify agricultural demand as seen in this file. For each time series data entry, the total agricultural demand must be specified for each subregion. A conversion factor that converts listed data to the simulation unit of volumetric flow rate is a required input, as well as the number of time steps to update the demand data and the repetition frequency of the data file. The input included in Unit 19 is listed below:

FACTDAGF	Factor to convert the agricultural demand to the simulation unit of volumetric flow rate
NSPDAGF	Number of time steps to update the agricultural demand data
NFQDAGF	Repetition frequency of the agricultural demand data (enter zero if full time series data is supplied)
ITDA	Time (defined for the convenience of the user; it is not used in IWFM internally)
RDMAG	Subregional agricultural water demand, $[L^3/T]$

```
C*******************************************************************************
C
C                  INTEGRATED WATER FLOW MODEL (IWFM)
C                        *** Version ### ***
C
C*******************************************************************************
C
C          AGRICULTURAL WATER SUPPLY REQUIREMENT DATA FILE
C                     for IWFM Simulation
C                         (Unit 19)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  AGDEMAND.DAT
C
C*******************************************************************************
C                           File Description
C
C   This data file contains the agricultural water demand for
C   each sub-region for the model simulation period. This file
C   is required only if KOPTDM in the main control file (Unit 5)
C   is set to zero.
C
C*******************************************************************************
C             Agricultural Water Supply Requirement Data Specifications
C
C   FACTDAGF;  Conversion factor for the agricultural supply requirement
C   NSPDAGF ;  Number of time steps to update the agricultural supply requirement data
C   NFQDAGF ;  Repetition frequency of the agricultural supply requirement data
C                (enter 0 if full time series data is supplied)
C
C------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C------------------------------------------------------------------------------
    43560000.0                  / FACTDAGF
    30                          / NSPDAGF
    0                           / NFQDAGF
C------------------------------------------------------------------------------
C             Agricultural Water Supply Requirement Data
C
C   The following lists the agricultural water supply requirement for each
C     sub-region on a time-series basis for the model simulation period.
C
C   ITDA;    Time
C   RDMAG;   Sub-regional agricultural water supply requirement; [L^3/T]
C
C------------------------------------------------------------------------------
C ITDA     RDMAG(1)  RDMAG(2)  RDMAG(3) ...
C------------------------------------------------------------------------------
   1        4       15      11      0       20      3
  31        0       0       0       0       0       0
  61        0       0       0       0       0       0
  91        0       0       0       0       0       0
  121       0       0       0       0       0       0
  151       0       1       0       0       0       0
  181       7       31      36      8       44      7
  211       7       31      65      32      79      16
    .       .        .       .       .       .       .
    .       .        .       .       .       .       .
    .       .        .       .       .       .       .
```

Urban Water Demand File Unit 20

This data file contains the time series data for the urban water demand for the modeled areas, which includes both the indoor and outdoor urban water use. The input data in this file is similar to the input data in the agricultural demand file (Unit 19). The appropriate conversion factor for the urban demand, the number of time steps to update the urban demand data and the repetition frequency of the data must be specified for the urban water demand time series data. The information to follow is the subregional urban water demand. The description of the variables used in Unit 20 is as follows:

FACTDU	Conversion factor for urban water demand
NSPDU	Number of time steps to update the urban demand data
NFQDU	Repetition frequency of the urban demand data (enter zero if full time series data is supplied)
ITDU	Time (defined for the convenience of the user; it is not used in IWFM internally)
RDMUR	Urban water demand specified for each subregion, [L^3/T]

```
C*******************************************************************************
C
C                  INTEGRATED WATER FLOW MODEL (IWFM)
C                        *** Version ### ***
C
C*******************************************************************************
C
C                  URBAN WATER DEMAND DATA FILE
C                      for IWFM Simulation
C                           (Unit 20)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  URBDEMAND.DAT
C
C*******************************************************************************
C                             File Description
C
C   This data file contains the urban water demand on a time-series basis for each
C   subregion for the model simulation period. The urban water demand includes
C   indoor and outdoor water use for municipal and industrial purposes.
C
C*******************************************************************************
C                      Urban Water Demand Data Specifications
C
C   FACTDU;  Conversion factor for urban water demand
C   NSPDU ;  Number of time steps to update the urban water demand data
C   NFQDU ;  Repetition frequency of the urban water demand data
C             (enter 0 if full time series data is supplied)
C
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
    1452000.0                    / FACTDU
    30                           / NSPDU
     0                           / NFQDU
C-------------------------------------------------------------------------------
C                      Urban Water Demand Data
C
C   The following lists the urban water demand for each subregion.
C
C   ITDU;    Time
C   RDMUR;   Urban water demand by subregion; [L^3/T]
C
C-------------------------------------------------------------------------------
C ITDU    RDMUR(1)  RDMUR(2)  RDMUR(3) ...
C-------------------------------------------------------------------------------
    1      0.0       0.3
    2      0.0       0.3
    3      0.0       0.3
    4      0.0       0.3
    5      0.0       0.3
    6      0.0       0.3
    7      0.0       0.4
    8      0.0       0.4
    9      0.0       0.4
   10      0.0       0.4
   11      0.0       0.4
   12      0.0       0.4
```

Stream Inflow File Unit 21

The stream inflow data file contains the time series for all inflows into the modeled streams. Number of time steps to update the inflow data and repetition frequency are both set by the user. Stream nodes that receive inflow from outside the modeled area are specified, as well as the columns containing the values of stream inflow data to each of the listed stream nodes. If there is a zero for any given stream flow, then that column is not used in the simulation. To help identify the nodes, a description following the stream node number can be used. The following variables are specified in this file:

NCOLSTRM	Total number of stream inflows
FACTSTRM	Conversion factor for stream inflows
NSPSTRM	Number of time steps to update the stream inflows
NFQSTRM	Repetition frequency of the stream inflow data
IRST	Stream node where inflow occurs; a value of zero in this column indicates that the corresponding data set is not used, and the stream inflow is taken to be zero
ITST	Time (defined for the convenience of the user; it is not used in IWFM internally)
ASTRM	Stream inflow at the specified stream node; negative values indicate water removed from the corresponding stream node

```
C*******************************************************************************
C
C               INTEGRATED WATER FLOW MODEL (IWFM)
C                     *** Version ### ***
C
C*******************************************************************************
C
C                  STREAM INFLOW DATA FILE
C                   for IWFM Simulation
C                        (Unit 21)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  INFLOW.DAT
C
C*******************************************************************************
C                           File Description
C
C   This data file contains the inflows to the stream nodes that are modeled.
C
C*******************************************************************************
C                       Stream Inflow Data Specifications
C
C   NCOLSTRM; Total number of stream inflows
C   FACTSTRM; Conversion factor for stream inflow
C   NSPSTRM ; Number of time steps to update the stream inflows
C   NFQSTRM ; Repetition frequency of the stream inflow data
C              (enter 0 if full time series data is supplied)
C
C-------------------------------------------------------------------------------
C   VALUE                         DESCRIPTION
C-------------------------------------------------------------------------------
    58                            /NCOLSTRM
    1452000.0                     /FACTSTRM
    30                            /NSPSTRM
     0                            /NFQSTRM
C-------------------------------------------------------------------------------
C                       Stream Inflow Data
C
C   The following lists the stream nodes for which a stream inflows are
C   given for and the time-series stream inflows at each of these stream nodes.
C
C   IRST;    Stream node where inflow occurs
C            (a '0' in this column indicates that the corresponding
C             data set is not used )
C   ITST ;   Time
C   ASTRM;   Stream inflow at the specified stream node; [L^3/T]
C              (negative values indicate water removed from
C               the corresponding stream node)
C
C-------------------------------------------------------------------------------
C   IRST                          Stream Description (optional)
C-------------------------------------------------------------------------------
    205                           / 1:
    211                           / 2:
    220                           / 3:
      .                             .
      .                             .
      .                             .
      0                           /53:
      0                           /54:
     11                           /55:
    424                           /56:
     69                           /57:
     80                           /58:
C-------------------------------------------------------------------------------
C   ITST    ASTRM(1)  ASTRM(2)  ASTRM(3) ...
C-------------------------------------------------------------------------------
C        1       2       3       4       5  ......   56      57      58
192110  232     7.5     15.7    9       0  ......   0       0       0
192111  237     22.5    19.5    17.9    2  ......   0       0       0
192112  335     49.6    29.1    52.6    21 ......   0       0       0
     .  .       .       .       .       .  ......   .       .       .
     .  .       .       .       .       .  ......   .       .       .
     .  .       .       .       .       .  ......   .       .       .
199807  912.6   19.92   50.24   30.44   9  ......   4.9     1.2     6
199808  903.68  9.1     33.2    10.94   4  ......   7       0       0
199809  660.97  7.14    26.72   7.26    3  ......   0       0       0
```

Crop Demand Parameter File Unit 22

The data in this file is used to compute the agricultural water demand of each subregion in the modeled area for the simulation period. The user has the option to compute agricultural demand within IWFM by setting KOPTDM to 1 in the main input file (Unit 5) and specifying agricultural demand parameters or to specify agricultural demand in Unit 19, directly.

This file contains the minimum soil moisture requirements and seasonal application efficiency of each crop in every subregion within the modeled area, for a time period and frequency that is determined by the user. The top line of input for each time step (and subregion) is minimum soil moisture requirements and the bottom line is for the seasonal application efficiencies. The following is a list of the variables used in this data file:

NSPDAG	Number of time steps to update the crop demand data
NFQDAG	Repetition frequency of the crop demand data
TIME	Time (defined for the convenience of the user; it is not used in IWFM internally)
IR	Subregion number
SMMIN	Minimum soil moisture requirement for a particular crop as a fraction of field capacity. It is given in the first data line for each region; [dimensionless]

CREFF	Crop efficiency for a particular crop at the specified time, given in the second data line for each region. If no irrigation is required, enter 0

```
C*******************************************************************************
C
C               INTEGRATED WATER FLOW MODEL (IWFM)
C                      *** Version ### ***
C
C*******************************************************************************
C
C               CROP DEMAND PARAMETER DATA FILE
C                   for IWFM Simulation
C                        (Unit 22)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  CROPDEMAND.DAT
C
C*******************************************************************************
C                           File Description
C
C   This data file contains the minimum soil moisture requirements and the
C   crop efficiency for each crop.
C
C*******************************************************************************
C          Minimum Soil Moisture Requirements and Crop Efficiency
C                        Data Specifications
C
C   NSPDAG ; Number of time steps to update the min. soil moisture requirement data
C   NFQDAG ; Repetition frequency of the crop demand data
C              (enter 0 if full time series data is supplied)
C
C-------------------------------------------------------------------------------
C   VALUE                        DESCRIPTION
C-------------------------------------------------------------------------------
     30                          / NSPDAG
     12                          / NFQDAG
C-------------------------------------------------------------------------------------------
C          Minimum Soil Moisture Requirements and Crop Efficiency Data
C
C   TIME ;  Time
C   IR   ;  Region number
C   SMMIN;  Minimum soil moisture requirement for a particular crop as a fraction of field
C             capacity. It is given in the first data line for each region; [dimensionless]
C   CREFF;  Crop efficiency for a particular crop at the specified time. It is
C             given in the second data line for each region.If no irrigation is
C             required, enter 0.
C
C-------------------------------------------------------------------------------------------
C                 SMMIN(1)  SMMIN(2)  SMMIN(3) ...
C  TIME   IR      CREFF(1)  CREFF(2)  CREFF(3) ...
C-------------------------------------------------------------------------------------------
    10       1   0.44   0.50
                 0.65   0.70
             2   0.44   0.50
                 0.65   0.70
    11       1   0.44   0.50
                 0.65   0.70
             2   0.44   0.50
                 0.65   0.70
     .       .      .      .
                    .      .
             .      .      .
                    .      .
     .       .      .      .
                    .      .
             .      .      .
                    .      .
     .       .      .      .
                    .      .
             .      .      .
     8       1   0.44   0.50
                 0.65   0.70
             2   0.44   0.50
                 0.65   0.70
     9       1   0.44   0.50
                 0.65   0.70
             2   0.44   0.50
                 0.65   0.70
```

Pumping Specification File Unit 23

The pumping specification data file contains the information for all wells and/or elemental sinks within the modeled area. Pumping specifications that change throughout the simulation period can be specified by setting the number of pumping specifications (NPUSP). The time step at which a particular pumping specification information will be utilized (ITPUSP) as well as number of sinks must be given. The distribution options for groundwater pumping should also be set. The subregion number that the pumping is delivered to and the corresponding column in the supply adjustment specification data file (Unit 12) are also listed in this file. Note that the maximum pumping amounts that are used during automated supply adjustment to limit the pumping amounts (see variables ICWLMAX, FWLMAX, ICSKMAX and FSKMAX) are not utilized in this version of IWFM. The relative proportions (or fractions) of pumping by aquifer layers are also listed for each sink. The variable descriptions for the pumping data file are as follows:

NPUSP	Number of pumping specifications given
ITPUSP	Time step at which the pumping specification data will be utilized
NSINK	Number of elements where pumping is taking place
IOPT	Option for distributing the groundwater pumping (0 = distribute pumping according to the specified fractions, 1 = distribute pumping in proportion to the specified fraction multiplied by the total area of the element, 2 = distribute pumping in proportion to the specified fraction multiplied by the total of agricultural and urban area within the element, 3 = distribute pumping in

	proportion to the specified fraction multiplied by the agricultural area of the element)
ID	Well/element identification number
ICOLWL	Well pumping (this number corresponds to the appropriate data column in the pumping data file, Unit 24)
ICFIRIGWL	Fraction of the well pumping that is used for agricultural purposes (this number corresponds to the data column in the irrigation fractions data file, Unit 27)
FRACWL	Relative proportion of the pumping as specified by ICOLWL to be applied to well, ID
IRGWL	Subregion number where the pumping from a well is delivered to; enter zero if pumping is exported outside the model area, enter –1 if the pumping is used in the same element that the well is located
ICADJWL	Supply adjustment specification (this number corresponds to the data column in the supply adjustment specifications data file, Unit 12)
ICWLMAX	Maximum pumping amount to be used during automated supply adjustment (this number corresponds to the data column in the pumping data file, Unit 24); not utilized in this version of IWFM
FWLMAX	Fraction of data value specified in column ICWLMAX to be used as maximum pumping amount; not utilized in this version of IWFM

ICOLSK	Data column in the pumping data file (Unit 24) which corresponds to sink ID
ICFIRIGSK	Fraction of the elemental pumping that is used for agricultural purposes (this number corresponds to the data column in the irrigation fractions data file, Unit 27)
FRACSK	Relative proportion of the pumping in column ICOLSK to be applied to element ID
FRACSKL	The distribution factor of elemental pumping for each layer (i.e. for layers 1 to NL)
IRGSK	Subregion number where the pumping is delivered to; enter zero if pumping is exported outside the model area; enter –1 if the pumping is used in the same element
ICADJSK	Supply adjustment specification (this number corresponds to the data column in the supply adjustment specifications data file, Unit 12)
ICSKMAX	Maximum pumping amount to be used during automated supply adjustment (this number corresponds to the data column in the pumping data file, Unit 24); not utilized in this version of IWFM
FSKMAX	Fraction of data value specified in column ICSKMAX to be used as maximum pumping amount; not utilized in this version of IWFM

```
C*******************************************************************************
C
C               INTEGRATED WATER FLOW MODEL (IWFM)
C                     *** Version ### ***
C
C*******************************************************************************
C
C                PUMPING SPECIFICATION DATA FILE
C                    for IWFM Simulation
C                         (Unit 23)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  PUMPSPEC.DAT
C
C*******************************************************************************
C                          File Description
C
C   This data file contains the specification data for well pumping and
C   element pumping (sinks).
C
C*******************************************************************************
C
C   NPUSP;  Number of pumping specifications given
C
C-------------------------------------------------------------------------------
C   VALUE                        DESCRIPTION
C-------------------------------------------------------------------------------
     1                           / NPUSP
C-------------------------------------------------------------------------------
C                      General Pumping Specifications
C
C   ITPUSP;  Time step at which the pumping specifications data will be utilized
C   NSINK ;  Number of elements used for element pumping
C
C   IOPT  ;  Option for distribution of element pumping (enter a value for each element pumping column)
C             Enter 0 - to distribute the pumping according to the given fraction
C                       below
C             Enter 1 - to distribute the pumping in proportion to the fraction
C                       times the total area of the element
C             Enter 2 - to distribute the pumping in proportion to the fraction
C                       times the developed area (ag. and urban) within the element
C             Enter 3 - to distribute the pumping in proportion to the fraction
C                       times the developed area (ag. only) within the element
C-------------------------------------------------------------------------------
C   VALUE                        DESCRIPTION
C-------------------------------------------------------------------------------
     1                           / ITPUSP
     5                           / NSINK
     0 0                         / IOPT
C-------------------------------------------------------------------------------
C*******************************************************************************
C                    Well Pumping Specifications
C   (Skip if no wells are being modeled, ie, NWELL = 0 as specified in preprocessor)
C
C   ID       ; Well identification number
C   ICOLWL   ; Well pumping - this number corresponds to the appropriate data column
C                in the pumping data file (Unit 24)
C   ICFIRIGWL; Fraction of the pumping that is used for irrigation purposes -
C                this number corresponds to the appropriate data column in the
C                irrigation fractions data file (Unit 27)
C   FRACWL   ; Relative proportion of the pumping in column ICOLWL to be applied
C                to well ID
C   IRGWL    ; Subregion number where the pumping is delivered to;
C                Enter 0, if pumping is exported to outside the model area
C                Enter -1, if the pumping is used in the same element
C   ICADJWL  ; Supply adjustment specification - this number corresponds to
C                the data column in the supply adjustment specifications
C                data file (Unit 12)
C   ICWLMAX  ; Maximum pumping amount - this number corresponds to the
C                appropriate data column in the pumping data file (Unit 24)
C   FWLMAX   ; Fraction of data value specified in column ICWLMAX to be used as
C                maximum pumping amount
C
C-------------------------------------------------------------------------------
C   ID   ICOLWL   ICFIRIGWL     FRACWL     IRGWL    ICADJWL  ICWLMAX  FWLMAX
C-------------------------------------------------------------------------------
*
*
C-------------------------------------------------------------------------------
C*******************************************************************************
C                      Elemental Pumping Specifications
C         (Skip if elemental pumping is not specified, ie, NSINK = 0)
C
C   ID       ; Element identification number corresponding to the pumping
C   ICOLSK   ; Element pumping - this number corresponds to the appropriate data
C                column in the pumping data file (Unit 24)
C   ICFIRIGSK; Fraction of the pumping that is used for irrigation purposes -
C                this number corresponds to the appropriate data column in the
```

```
C                irrigation fractions data file (Unit 27)
C   FRACSK    ; Relative proportion of the pumping in column ICOLSK to be applied
C                to element ID
C   FRACSKL   ; The distribution factor of pumping for each aquifer layer; i.e. for
C                layers 1 to NL
C   IRGSK     ; Subregion number where the pumping is delivered to
C                Enter 0, if pumping is exported to outside the model area
C                Enter -1, if the pumping is used in the same element
C   ICADJSK   ; Supply adjustment specification - this number corresponds to
C                the data column in the supply adjustment specifications
C                data file (Unit 12)
C   ICSKMAX   ; Maximum pumping amount - this number corresponds to the
C                appropriate data column in the pumping data file (Unit 24)
C   FSKMAX    ; Fraction of data value specified in column ICSKMAX to be used as
C                maximum pumping amount
C
C-------------------------------------------------------------------------------------------
C ID   ICOLSK   ICFIRIGSK   FRACSK    FRACSKL(1)   FRACSKL(2) IRGSK    ICADJSK    ICSKMAX   FSKMAX
C-------------------------------------------------------------------------------------------
  73      1       2          1.0         1.0          1.0         1          1          0       0.0
  193     1       2          1.0         1.0          1.0         1          1          0       0.0
  333     1       1          1.0         1.0          1.0         2          1          0       0.0
  134     2       0          1.0         1.0          1.0         0          1          0       0.0
  274     2       0          1.0         1.0          1.0         0          1          0       0.0
```

Pumping Data File Unit 24

The pumping data file contains the time series information for the specified wells and/or elemental sinks from the pumping specification file (Unit 23). This file lists the number of pumping sets followed by conversion factor for the pumping data, number of time steps to update pumping and the repetition frequency for the pumping data:

NCOLPUMP	Number of pumping sets
FACTPUMP	Conversion factor for pumping data
NSPPUMP	Number of time steps to update pumping data
NFQPUMP	Repetition frequency of the pumping data (enter 0 if full time series data is supplied)
ITPU	Time (defined for the convenience of the user; it is not used in IWFM internally)
APUMP	Pumping rate (a negative value represents pumping whereas a positive value represents recharge), $[L^3/T]$

```
C*******************************************************************************
C
C                INTEGRATED WATER FLOW MODEL (IWFM)
C                      *** Version ### ***
C
C*******************************************************************************
C
C                     PUMPING DATA FILE
C                    for IWFM Simulation
C                         (Unit 24)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  PUMP.DAT
C
C*******************************************************************************
C                           File Description:
C
C   This data file contains the pumping data for each set of pumping
C   specified in the pumping specification file.
C
C*******************************************************************************
C                         Pumping Data Specifications
C
C   NCOLPUMP; Number of pumping sets
C   FACTPUMP; Conversion factor for pumping data
C   NSPPUMP ; Number of time steps to update pumping data
C   NFQPUMP ; Repetition frequency of the pumping data
C              (enter 0 if full time series data is supplied)
C
C-------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C-------------------------------------------------------------------------------
     2                          / NCOLPUMP
    1452000.0                   / FACTPUMP
    30                          / NSPPUMP
    12                          / NFQPUMP
C-------------------------------------------------------------------------------
C                         Pumping Data
C
C   The following lists the pumping rates.
C
C   ITPU ;   Time
C   APUMP;   Pumping rate; [L^3/T]
C-------------------------------------------------------------------------------
C ITPU    APUMP(1)  APUMP(2)  APUMP(3) ...
C-------------------------------------------------------------------------------
   1     -3.50      0.0
   2     -3.50      0.0
   3     -3.50      0.0
   4     -3.50      0.0
   5     -3.50      0.0
   6     -3.50      0.0
   7       0.0      6.00
   8       0.0      6.00
   9       0.0      6.00
   10      0.0      6.00
   11      0.0      6.00
   12      0.0      6.00
```

Diversion Specification File Unit 25

This data file specifies the surface water diversion locations, bypass locations and recharge zones for all diversions and bypasses modeled. Deliveries, recoverable losses and non-recoverable losses are specified for each diversion and bypass.

Surface Water Diversions

The first portion of the data file includes the number of surface water diversions modeled and the diversion specifications for each diversion modeled. Based on this information, the appropriate diversion data columns in Unit 26 are used to model diversions.

NRDV	Number of surface water diversions in the model
ID	Surface water diversion identification number
IRDV	Stream node from where the diversion takes place. Enter '0' if the stream node is not within the model domain
ICDVMAX	Maximum diversion amount (this number corresponds to the data column in the diversion data file, Unit 26); not utilized in this version of IWFM
FDVMAX	Fraction of data value specified in column ICDVMAX to be used as maximum diversion amount; not utilized in this version of IWFM
ICOLRL	Column number in the diversion data file used to define the recoverable loss corresponding to diversion number ID

FRACRL	Relative proportion of the data value that is specified by ICOLRL to be used as recoverable loss
ICOLNL	Column number in the diversion data file that corresponds to the non-recoverable loss from diversion number ID
FRACNL	Relative proportion of the data value that is specified by ICOLNL to be used as non-recoverable loss
NDLDV	Number of subregions to which diverted surface water is delivered
IRGDL	Subregion number to which the delivery is made (1...NDLV)
ICOLDL	Delivery to subregion IRGDL; this number corresponds to the appropriate data column in the diversion data file (Unit 26)
FRACDL	Relative proportion of the data value that is specified by ICOLDL to be used as delivery to subregion IRGDL
ICFSIRIG	Fraction of the delivery that is used for irrigation purposes (remaining amount will be used to supply the user specified urban demand)
ICADJ	Supply adjustment specification (this number corresponds to the appropriate data column in the supply adjustment specifications data file (Unit 12)

Recharge Zone for Each Diversion Point

Each diversion point must have a related recharge zone. The recoverable loss specified above becomes groundwater recharge at the recharge zone which comprises of

elements. The following list describes the variables used to indicate a recharge zone for each diversion point:

ID	Recharge zone identification number; recharge zone ID should be the same as diversion identification number
NERELS	Total number of elements through which recharge occurs
IERELS	Element number through which recharge occurs
FERELS	Relative proportion of the recoverable loss to be applied to element IERELS as recharge

Bypass Configuration Specifications

This portion indicates the total number of bypasses modeled, conversion factors, as well as each bypass identification number and the related bypass information. This information defines the stream nodes that the bypass originates from and ends at, and either diversion flows or a rating table detailing the available flows for each bypass number:

NDIVS	Number of bypasses modeled
FACTX	Factor to convert DIVX to the simulation unit of volumetric flow rate
FACTY	Factor to convert DIVY to the simulation unit of volumetric flow rate
ID	Bypass identification number
IA	Stream node number where bypass flow is exported from
IDIVT	Stream node number where bypass flow is imported to

IDIVC — If positive, IDIVC is the column number in the diversion data file (Unit 26) to be used for bypass flow. If negative, IDIVC is the number of points in the rating table

DIVRL — Fraction of the bypass assigned as recoverable loss

DIVNL — Fraction of the bypass assigned as non-recoverable loss

DIVX — Stream flow available at stream node IA, [L^3/T]

DIVY — Bypass amount corresponding to DIVX, [L^3/T]

Seepage Locations for Bypass Canals

This section of data serves a similar purpose as the data that defines a recharge zone for each diversion point modeled. For each bypass modeled, the seepage to groundwater occurring from a bypass flow is based on the bypass recoverable loss. The following parameters define the elements where seepage from a bypass occurs, as well as the amount of the recoverable loss from a bypass flow that seeps into the groundwater.

ID — Recharge zone identification number; recharge zone ID should match bypass identification number

NERELS — Total number of elements encompassing the recharge zone associated with the corresponding bypass

IERELS — Element number included in the recharge zone associated with the bypass. If water is bypassed to a lake, specify IERELS as the lake identification number and include a negative sign prior to the lake ID

FERELS	Relative proportion of the recoverable loss to be applied to element IERELS as recharge

```
C*******************************************************************************
C
C                  INTEGRATED WATER FLOW MODEL (IWFM)
C                        *** Version ### ***
C
C*******************************************************************************
C
C             SURFACE WATER DIVERSION SPECIFICATION DATA FILE
C                         for IWFM Simulation
C                              (Unit 25)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  DIVERSPEC.DAT
C
C*******************************************************************************
C                           File Description
C
C  This data file contains the specification data for surface water diversions
C  and bypasses.
C
C*******************************************************************************
C                  Surface Water Diversion Specifications
C
C   The following lists the number of surface water diversions and
C   specifications for each diversion that is included in the model.
C
C   NRDV;    Number of surface water diversions included in the model.
C------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C------------------------------------------------------------------------------
     4                          / NRDV
C------------------------------------------------------------------------------
C
C   The following lists the specifications for each surface water diversion
C   (skip if no diversions are modeled, i.e. NRDV = 0)
C
C   ID      ; Surface water diversion identification number
C   IRDV    ; Stream node from where the diversion takes place. Enter '0' if
C               the stream node is outside the model area.
C   ICDVMAX ; Maximum diversion amount - this number corresponds to the
C               appropriate data column in the diversion data file Unit 26
C   FDVMAX  ; Fraction of data value specified in column ICDVMAX to be used as
C               maximum diversion amount
C   ICOLRL  ; Recoverable loss -  this number corresponds to the appropriate
C               data column in the diversion data file Unit 26
C   FRACRL  ; Relative proportion of the data value that is specified by ICOLRL
C               to be used as recoverable loss
C   ICOLNL  ; Non-recoverable loss - this number corresponds to the appropriate
C               data column in the diversion data file Unit 26
C   FRACNL  ; Relative proportion of the data value that is specified by ICOLNL
C               to be used as non-recoverable loss
C   NDLDV   ; Number  of sub-regions to which diverted surface water is delivered
C   IRGDL   ; Sub-region number to which the delivery is made (1...NDLDV)
C   ICOLDL  ; Delivery to sub-region IRGDL - this number corresponds to the
C               appropriate data column in the diversion data file Unit 26
C   FRACDL  ; Relative proportion of the data value that is specified by ICOLDL
C               to be used as delivery to subregion IRGDL
C   ICFSIRIG; Fraction of the delivery that is used for irrigation purposes -
C               this number corresponds to the appropriate data column in the
C               irrigation fraction data file Unit 27 (remaining amount will be used to
C               supply the user specified urban demand)
C   ICADJ   ; Supply adjustment specification - this number corresponds to the appropriate
C               data column in the supply adjustment specifications data file Unit 12
C
C-------------------------------------------------------------------------------------------------------------------
C   ID   IRDV  ICDVMAX  FDVMAX  ICOLRL   FRACRL    ICOLNL   FRACNL   NDLDV  IRGDL   ICOLDL   FRACDL  ICFSIRIG  ICADJ
C-------------------------------------------------------------------------------------------------------------------
     1    9       0      0.0     1         0.01      1       0.01      1      1       1        0.98     2         0
     2    12      0      0.0     2         0.02      2       0.02      2      1       2        0.98     2         0
                                                                                  0       3        0.98     3         0
     3    0       0      0.0     4         0.01      4       0.01      1      1       4        0.98     2         0
     4    22      0      0.0     5         0.01      5       0.01      1      0       5        0.98     4         0
C-------------------------------------------------------------------------------------------------------------------
C
C                   Recharge zone for each diversion point
C       (Skip if no diversions are being modeled, i.e. NRDV = 0)
C
C   ID    ;  Recharge zone identification number
C              (*Note* Recharge zone ID's should match river diversion ID numbers)
C   NERELS;  Total number of elements through which recharge occurs
C   IERELS;  Element number through which recharge occurs
C   FERELS;  Relative proportion of the recoverable loss to be applied to
C               element IERELS as recharge
C
C------------------------------------------------------------------------------
C    ID         NERELS      IERELS     FERELS
C------------------------------------------------------------------------------
     1           2           251        1.0
```

```
                              270        1.0
     2            1           191        1.0
     3            0           0          0.0
     4            0           0          0.0
C-------------------------------------------------------------------------------
C*******************************************************************************
C
C                 Bypass Configuration Specifications
C
C   NDIVS;  Number of bypasses
C   FACTX;  Conversion factor for DIVX
C   FACTY;  Conversion factor for DIVY
C   ID   ;  Bypass identification number
C   IA   ;  Stream node number where bypass is exported
C   IDIVT;  Stream node number where bypass is imported
C   IDIVC;  If positive, IDIVC is the column number in the diversion data file Unit 26 for bypass flow
C           If negative, IDIVC is the number of points in the diversion rating table
C   DIVRL;  Fraction of the diversion assigned as recoverable loss
C   DIVNL;  Fraction of the diversion assigned as non-recoverable loss
C   DIVX ;  Stream flow available at stream node IA; [L^3/T]
C   DIVY ;  Diversion amount corresponding to DIVX; [L^3/T]
C
C-------------------------------------------------------------------------------
C   VALUE                      DESCRIPTION
C-------------------------------------------------------------------------------
     2                          / NDIVS
     43560.0                    / FACTX
     43560.0                    / FACTY
C-------------------------------------------------------------------------------------------------------------------
C  ID   IA  IDIVT   IDIVC   DIVRL  DIVNL
C                           DIVX   DIVY ( this rating table should follow if IDIVC < 0 )
C-------------------------------------------------------------------------------------------------------------------
   1    13      0     6      0.0     0.0
   2    17     21    -4      0.0     0.1
                              0.0     0.0
                              1.0     0.5
                              18.0    9.0
                              8000.0  4000.0
C-------------------------------------------------------------------------------
C
C               Seepage locations for bypass canals
C
C      The following information specifies the recharge zone for each bypass.
C      (Skip if no bypass is being modeled, i.e. NDIVS = 0)
C
C   ID    ;  Recharge zone identification number
C              (*Note* Recharge zone ID's should match bypass ID numbers)
C   NERELS;  Total number of elements through which recharge occurs
C   IERELS;  Element number through which recharge occurs
C             (If bypass to lake elements, provide negative sequential lake
C              number, as in the LAKE input data file)
C   FERELS;  Relative proportion of the recoverable loss to be applied to
C             element IERELS as recharge.
C
C-------------------------------------------------------------------------------
C    ID         NERELS      IERELS     FERELS
C-------------------------------------------------------------------------------
   1              0             0         0
   2              0             0         0
```

Surface Water Diversion Data File Unit 26

The surface water diversion data file contains the diversions within the modeled area for the simulation time period. This data file is used in conjunction with the surface water diversion specification file (Unit 25) to route the water to delivery points, indicate bypass flows, the recoverable losses with respect to recharge zone and the non-recoverable losses. The following variables are used in this file:

NCOLDV	Number of surface water diversion points
FACTDV	Conversion factor for surface water diversion data
NSPDV	Number of time steps to update the surface water diversion data
NFQDV	Repetition frequency of the surface water diversion data; a value of zero indicates that a full time series data set is supplied
ITDV	Time (defined for the convenience of the user; it is not used in IWFM internally)
ADIVS	Diversion rate corresponding to the stream node specified in diversion specification file, $[L^3/T]$

```
C*******************************************************************************
C
C                  INTEGRATED WATER FLOW MODEL (IWFM)
C                        *** Version ### ***
C
C*******************************************************************************
C
C                  SURFACE WATER DIVERSION DATA FILE
C                        for IWFM Simulation
C                             (Unit 26)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  DIVER.DAT
C
C*******************************************************************************
C                             File Description
C
C   This data file contains the surface water diversion and bypass data
C   for the stream nodes that have been specified in the surface water
C   diversion specification data file. Maximum diversion rates to be used
C   in supply adjutment computations are also listed in this file.
C
C*******************************************************************************
C                    Surface Water Diversion Data Specifications
C
C   The following lists the time-series surface water diversions for
C   each of the stream nodes where surface diversions have been specified.
C
C   NCOLDV;  Number of surface water diversions sites
C   FACTDV;  Conversion factor for surface water diversions
C   NSPDV ;  Number of time steps to update the surface water diversion data
C   NFQDV ;  Repetition frequency of the surface water diversion data
C             (enter 0 if full time series data is supplied)
C
C-------------------------------------------------------------------------------
C   VALUE                        DESCRIPTION
C-------------------------------------------------------------------------------
     6                           / NCOLDV
     1452000.0                   / FACTDV
     3600                        / NSPDV
     0                           / NFQDV
C*******************************************************************************
C                    Surface Water Diversion Data
C
C   ITDV ;  Time
C   ADIVS;  Diversion rate corresponding to the stream node specified; [L^3/T]
C            in diversion specification file (if the data column is used for maximum
C            diversion rate, then a value of -99.0 denotes that there is no upper
C            limit for the diversion rate)
C-------------------------------------------------------------------------------
C   ITDV   ADIVS(1)  ADIVS(2)  ADIVS(3) ...
C-------------------------------------------------------------------------------
   1      3.0       3.0        3.0     3.0     3.0     6.0
```

Irrigation Fractions Data File Unit 27

This data file contains the time series data for the fraction of pumping and surface water diversions to be used for agricultural purposes. The pumping and surface water diversions are associated with each of the data columns through pumping specifications (Unit 23) and surface water diversion specification (Unit 25) data files. The following variables are used:

NCOLIRF	Number of columns in the irrigation fractions data file
NSPIRF	Number of time steps to update the irrigation fractions
NFQIRF	Repetition frequency of the irrigation fractions data; a value of zero indicates that a full time series data set is supplied
ITIRF	Time (defined for the convenience of the user; it is not used in IWFM internally)
FIRIG	Irrigation fraction used for agricultural puprposes; (1–FIRIG) is used for urban water requirements

```
C*******************************************************************************
C
C                  INTEGRATED WATER FLOW MODEL (IWFM)
C                        *** Version ### ***
C
C*******************************************************************************
C
C       IRRIGATION FRACTIONS FOR PUMPING AND SURFACE WATER DIVERSIONS
C                        for IWFM Simulation
C                             (Unit 27)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  IRIGFRAC.DAT
C
C*******************************************************************************
C                          File Description
C
C   This data file contains the time series data for the fraction of pumping
C   and surface water diversions to be used for agricultural purposes.
C
C*******************************************************************************
C                        Irrigation Fractions Data Specifications
C
C   NCOLIRF;  Number of columns in the irrigation fractions data file
C   NSPIRF ;  Number of time steps to update the irrigation fractions
C   NFQIRF ;  Repetition frequency of the irrigation fractions data
C              (enter 0 if full time series data is supplied)
C
C-------------------------------------------------------------------------------
C   VALUE                  DESCRIPTION
C-------------------------------------------------------------------------------
      2                    / NCOLIRF
      1                    / NSPIRF
      1                    / NFQIRF
C-------------------------------------------------------------------------------
C                        Irrigation Fractions Data
C
C   ITIRF;  Time
C   FIRIG;  Irrigation fraction
C
C-------------------------------------------------------------------------------
C   ITIRF    FIRIG(1)  FIRIG(2)  FIRIG(3) ...
C-------------------------------------------------------------------------------
   1          0.0       1.0
```

Maximum Lake Elevation Data File Unit 28

This data file contains the time series data for the maximum lake elevations at the modeled lakes. The time-dependent maximum lake elevations at the modeled lakes are associated with each of the data columns through the ICHLMAX variable specified among the lake parameters in the parameter data file (Unit 7). The following variables are used in this file:

NCOLHLMX	Total number of time series data columns for maximum lake elevations
FACTHLMX	Conversion factor for maximum lake elevations
NSPHLMX	Number of time steps to update the maximum lake elevations
NFQHLMX	Repetition frequency of the maximum lake elevation data
ITHLMX	Time (defined for the convenience of the user; it is not used in IWFM internally)
HLMAX	Maximum lake elevation; [L]

```
C*******************************************************************************
C
C                  INTEGRATED WATER FLOW MODEL (IWFM)
C                        *** Version ### ***
C
C*******************************************************************************
C
C                  MAXIMUM LAKE ELEVATION DATA FILE
C                       for IWFM Simulation
C                            (Unit 28)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  MAXLKELEV.DAT
C
C*******************************************************************************
C                           File Description
C
C   This data file contains the time series data for the maximum lake elevations
C   at the modeled lakes.
C
C*******************************************************************************
C                       Maximum Lake Elevation Data Specifications
C
C   NCOLHLMX; Total number of time series data columns for maximum lake elevations
C   FACTHLMX; Conversion factor for maximum lake elevations
C   NSPHLMX ; Number of time steps to update the maximum lake elevations
C   NFQHLMX ; Repetition frequency of the maximum lake elevation data
C              (enter 0 if full time series data is supplied)
C
C------------------------------------------------------------------------------
C   VALUE                        DESCRIPTION
C------------------------------------------------------------------------------
      1                          / NCOLHLMX
      1.0                        / FACTHLMX
      1                          / NSPHLMX
      0                          / NFQHLMX
C------------------------------------------------------------------------------
C                       Maximum Lake Elevations Data
C
C   The following lists the maximum lake elevations at the modeled lakes.
C
C   ITHLMX ;   Time
C   HLMAX  ;   Maximum lake elevation; [L]
C
C------------------------------------------------------------------------------
C   ITHLMX    HLMAX(1)  HLMAX(2)  HLMAX(3) ...
C------------------------------------------------------------------------------
     1         285.0
     2         283.0
     3         282.0
     4         280.0
     .         .
     .         .
     .         .
```

Irrigation Water Re-use Factor Data File Unit 29

This data file contains the time series data for the fraction of the return flow from agricultural and urban lands that is re-used. The re-use factors are specified for agricultural urban lands for each subregion. The corresponding data column in this file is associated with each subregion and land use (in terms of agricultural and urban lands) combination through the parameter data file (Unit 7) under "Water Use Parameters" section. If this file is omitted, IWFM assumes that agricultural and urban return flows are not re-used. The following variables are used:

NRUF	Number of columns for re-use factors
NSPRUF	Number of time steps to update the re-use factors
NFQRUF	Repetition frequency of the re-use factor data; a value of zero indicates that a full time series data set is supplied
ITRUF	Time (defined for the convenience of the user; it is not used in IWFM internally)
RUF	Fraction of the return flow that is re-used

```
C*******************************************************************************
C
C                  INTEGRATED WATER FLOW MODEL (IWFM)
C                        *** Version ### ***
C
C*******************************************************************************
C
C              IRRIGATION WATER RE-USE FACTOR DATA FILE
C                       for IWFM Simulation
C                            (Unit 29)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  RUF.DAT
C
C*******************************************************************************
C                              File Description
C
C   This data file contains the factors for the re-use of irrigation water on a
C   time-series basis for each subregion for the model simulation period. It is
C   assumed that only the surface runoff (as opposed to tile drainage) from the
C   fields can be allocated for re-use.
C
C*******************************************************************************
C            Irrigation Water Re-use Factor Data Specifications
C
C   NRUF   ;  Number of columns for re-use factors
C   NSPRUF ;  Number of time steps to update the re-use factors
C   NFQRUF ;  Repetition frequency of the re-use factor data
C              (enter 0 if full time series data is supplied)
C
C------------------------------------------------------------------------------
C   VALUE                       DESCRIPTION
C------------------------------------------------------------------------------
     4                          / NRUF
     1                          / NSPRUF
     1                          / NFQRUF
C------------------------------------------------------------------------------
C                       Irrigation Water Re-use Factors
C
C   The following lists the irrigation water re-use factors for each subregion.
C
C   ITRUF;   Time
C   RUF  ;   Irrigation water re-use factor. It is defined as the ratio of the
C            surface runoff from the fields that is allocated to be re-used to the
C            total surface runoff; [dimensionless]
C
C------------------------------------------------------------------------------
C ITRUF   RUF(1)   RUF(2)   RUF(3) ....
C------------------------------------------------------------------------------
      1   0.00     0.00     0.73     0.83
```

Aquifer Parameter Over-write Data File Unit 30

This data file can be used to over-write selected parameter values at selected groundwater nodes. IWFM initially assigns parameter values to groundwater nodes through the information specified in the parameter data file (Unit 7). Sometimes it becomes necessary to modify some of the parameter values at selected groundwater nodes. One such situation is when IWFM is used in conjunction with an automated calibration program such as PEST (Paramater ESTimation program). PEST can automatically generate parameter values at specific groundwater nodes and this file can be used to over-write the previously specified values at these nodes. This file also allows the user to by-pass the need to generate excessive numbers of parametric grid groups when only a few parameter values at a few groundwater nodes need to be modified. The following variables are used in this data file:

NWRITE	Total number of groundwater nodes at which previously defined parameter values will be over-written
FKH	Conversion factor for horizontal hydraulic conductivity
FS	Conversion factor for specific storage coefficient
FN	Weighting factor for specific yield value
FV	Conversion factor for aquitard vertical hydraulic conductivity
FL	Conversion factor for aquifer vertical hydraulic conductivity
FSCE	Conversion factor for elastic storage coefficient
FSCI	Conversion factor for inelastic storage coefficient

ID	Groundwater node number for which one or more parameter values will be modified
LAYER	Aquifer layer in which groundwater node ID resides
PKH	Hydraulic conductivity that will over-write the previously defined value (enter −1.0 if hydraulic conductivity at this node will not be modified); [L/T]
PS	Specific storage that will over-write the previously defined value (enter −1.0 if specific storage at this node will not be modified); [1/L]
PN	Specific yield that will over-write the previously defined value (enter −1.0 if specific yield at this node will not be modified); [L/L]
PV	Aquitard vertical hydraulic conductivity that will over-write the previously defined value (enter −1.0 if aquitard vertical hydraulic conductivity at this node will not be modified); [L/T]
PL	Aquifer vertical hydraulic conductivity that will over-write the previously defined value (enter −1.0 if aquifer vertical hydraulic conductivity at this node will not be modified); [L/T]
SCE	Elastic storage coefficient that will over-write the previously defined value (enter −1.0 if elastic storage coefficient at this node will not be modified); [1/L]

SCI	Inelastic storage coefficient that will over-write the previously defined value (enter −1.0 if inelastic storage coefficient at this node will not be modified); [1/L]

```
C*******************************************************************************
C
C                  INTEGRATED WATER FLOW MODEL (IWFM)
C                        *** Version ### ***
C
C*******************************************************************************
C
C               AQUIFER PARAMETER OVER-WRITE DATA FILE
C                        for IWFM Simulation
C                            (Unit 30)
C
C
C             Project :  IWFM Version ### Release
C                        California Department of Water Resources
C             Filename:  OVERWRITE.DAT
C
C*******************************************************************************
C                           File Description
C
C   This data file contains node and layer numbers, and associated parameter
C   values to over-write values specified in the parameter data file (Unit 7).
C
C*******************************************************************************
C                Over-writing Parameter Value Data Specifications
C
C   NWRITE; Total number of groundwater nodes at which previously defined
C           parameter values will be over-written.
C
C-------------------------------------------------------------------------------
C   VALUE                        DESCRIPTION
C-------------------------------------------------------------------------------
    4179                         / NWRITE
C-------------------------------------------------------------------------------
C
C         Conversion factors for over-writing parameter values
C
C   FKH   ;  Conversion factor for horizontal hydraulic conductivity
C   FS    ;  Conversion factor for specific storage coefficient
C   FN    ;  Weighting factor for specific yield value
C   FV    ;  Conversion factor for aquitard vertical hydraulic conductivity
C   FL    ;  Conversion factor for aquifer vertical hydraulic conductivity
C   FSCE  ;  Conversion factor for elastic storage coefficient
C   FSCI  ;  Conversion factor for inelastic storage coefficient
C
C-------------------------------------------------------------------------
C  FKH         FS          FN         FV        FL       FSCE        FSCI
C-------------------------------------------------------------------------
   1.00        1.00        1.00       1.00      1.00     1.00        1.00
C-------------------------------------------------------------------------
C
C   The following lists the groundwater nodenumber, aquifer layer number and the
C    associated parameter values that will over-write the previously defined
C    values.
C    *** Enter -1.0 not to over-write the previously set values ***
C
C
C   ID   ;   Groundwater node number
C   LAYER;   Aquifer layer
C   PKH  ;   Hydraulic conductivity; [L/T]
C   PS   ;   Specific storage; [1/L]
C   PN   ;   Specific yield; [L/L]
C   PV   ;   Aquitard vertical hydraulic conductivity; [L/T]
C   PL   ;   Aquifer vertical hydraulic conductivity; [L/T]
C   SCE  ;   Elastic storage coefficient (Use SCE*DC if DC=0); [1/L]
C   SCI  ;   Inelastic storage coefficient (Use SCI*DC if DC=0); [1/L]
C            *Note* The above land subsidence parameters are only for interbed
C                   layers (i.e. clay layers)
C
C-------------------------------------------------------------------------------------------------------
C                Hydr.        Spec.          Spec.    Aquitard  Aquifer   Elastic   Inelastic
C                cond.        Stor.          Yld.       Vert.K  Vert.K   Stg. Coef. Stg. Coef.
C  ID   LAYER     PKH          PS             PN           PV       PL       SCE        SCI
C-------------------------------------------------------------------------------------------------------
     1     1   2404.766   9.9999997E-06  2.0151161E-02  -1.00   334.3762   -1.00      -1.00
     1     2   1052.881   5.0065097E-05  3.3468835E-02  -1.00   240.6059   -1.00      -1.00
     1     3   9706.813   1.0849720E-04  5.8463603E-02  -1.00   214.9347   -1.00      -1.00
     2     1   2407.003   1.0000001E-05  1.9952139E-02  -1.00   331.9574   -1.00      -1.00
     2     2   1044.410   5.0159750E-05  3.4741677E-02  -1.00   239.1580   -1.00      -1.00
     2     3   9612.228   1.1174077E-04  6.1085913E-02  -1.00   215.6135   -1.00      -1.00
     .     .       .           .              .           .        .          .          .
     .     .       .           .              .           .        .          .          .
     .     .       .           .              .           .        .          .          .
  1392     2   1393.980   1.9578732E-04  7.3446646E-02  -1.00   2.911047   -1.00      -1.00
  1392     3   680.7024   1.4334776E-04  5.9957355E-02  -1.00   7.285010   -1.00      -1.00
  1393     1   2391.534   9.9999997E-06  0.1486767      -1.00   4.609168   -1.00      -1.00
  1393     2   1437.810   2.3690333E-04  8.9009784E-02  -1.00   3.107419   -1.00      -1.00
  1393     3   759.8795   1.6385839E-04  9.4242930E-02  -1.00   6.028072   -1.00      -1.00
```

3.3. Output Files

IWFM generates ASCII and binary files based on the user preference in order to view and analyze the simulation results. Other than the standard ASCII output file (Unit 6) all output files are optional. To generate an output file, it is only necessary to specify a name for the file in the control input file (Unit 5). Omitting the name for an output file will suppress the generation of that file. Generation of some output files is dependent on the system being modeled. For instance, if a groundwater system with a single aquifer layer is modeled, defining a file name for layer vertical flow output file (Unit 49) will fail to generate the required file since there are no vertical flows being calculated.

The following sections describe each of the output files in detail.

Standard ASCII Output Unit 6

The ASCII output file provides the user with information that was processed in the simulation portion of IWFM. The user is encouraged to check the contents of this file after every run. The following list indicates the information available in this output file:

- Project title (specified in Unit 5)
- Date and time of run, which is determined internally within the program
- List of input files read in the pre-processing program and the associated date that the input files were modified. Output file names specified in Unit 5 are written to this file as well
- Various warning messages and errors

- Aquifer parameters depending on the option set by the user in the main input file (Unit 5)
- Convergence information on the iterative procedures at each time step
- Total CPU time consumed by the execution of the Simulation program

```
*********************************************************************************************
                                                IWFM
                                          Version 2.3 Release
                                                DWR
*********************************************************************************************

THIS RUN IS MADE ON 09/20/2005 AT 16:37:17

THE FOLLOWING FILES ARE USED IN THIS SIMULATION:
     2
     3
     4     OUTPUT1.BIN                                          09/20/2005  01:34
     5     MAIN.IN2                                             09/20/2005  04:37
     6     OUTPUT2.OUT
     7     PARAMETER.DAT                                        09/20/2005  04:32
     8     BOUND.DAT                                            09/20/2005  04:33
     9     BOUNDTSD.DAT                                         02/15/2005  02:17
    10     PRINT.DAT                                            02/15/2005  03:30
    11     INIT.DAT                                             02/15/2005  02:19
    12     SUPADJ.DAT                                           02/15/2005  02:22
    13     LANDUSE.DAT                                          02/15/2005  02:19
    14     CROPAREA.DAT                                         02/15/2005  02:17
    15     PRECIP.DAT                                           02/15/2005  02:21
    16     ET.DAT                                               02/15/2005  02:18
    17     TILEDRN.DAT                                          02/15/2005  02:22
    18     URBSPEC.DAT                                          02/15/2005  02:23
    19
    20     URBDEMAND.DAT                                        02/15/2005  02:23
    21     INFLOW.DAT                                           02/15/2005  02:18
    22     CROPDEMAND.DAT                                       02/15/2005  02:17
    23     PUMPSPEC.DAT                                         02/15/2005  02:22
    24     PUMP.DAT                                             02/15/2005  02:22
    25     DIVERSPEC.DAT                                        02/15/2005  02:18
    26     DIVER.DAT                                            02/15/2005  02:18
    27     IRIGFRAC.DAT                                         02/15/2005  02:19
    28     MAXLKELEV.DAT                                        02/15/2005  02:20
    29     RUF.DAT                                              09/20/2005  04:36
    30
    31     ZBUDGET.BIN
    32     SMWSHED.BIN
    33     SUBGRP.BIN
    34     DIVERDTL.BIN
    35     REACH.BIN
    36     LAKE.BIN
    37     LWU.BIN
    38     STRM.BIN
    39     SOIL.BIN
    40     GW.BIN
    41
    42
    43     FACEFLOW.OUT
    44     BNDFLX.OUT
    45     TDRN.OUT
    46     STRM.HYD
    47     GW.HYD
    48     GWHEAD.HYD
    49     VERTFLOW.OUT
    50     FNRESULTS.OUT
NOTE: SURFACE WATER DIVERSION WAS ADJUSTED, PUMPING WAS NOT ADJUSTED.

-------------------------------------------------
'IME STEP       1 AT       1.00 DAYS
-------------------------------------------------

                       *** SUPPLY ADJUSTMENT ITERATION:     1 ***
  ITER      CONVERGENCE          MAX.DIFF    VARIABLE       PUMP.CONV.    DRY LOCATION
  ---------------------------------------------------------------------------------
     1      195.230           21.0129          478      0.00000             0()
     2      5.83998           3.54401          289      0.00000             0()
     3      3.68873          0.660095           24      0.00000             0()
     4     0.205938         0.373303E-01        24      0.00000             0()
     5     0.404192E-04     0.201223E-04        21      0.00000             0()

                       *** SUPPLY ADJUSTMENT ITERATION:     2 ***
  ITER      CONVERGENCE          MAX.DIFF    VARIABLE       PUMP.CONV.    DRY LOCATION
  ---------------------------------------------------------------------------------
     1      195.063           21.0129          478      0.00000             0()
     2      5.43178           1.46387           22      0.00000             0()
     3     0.435922          0.179985          289      0.00000             0()
     4     0.286186E-01      0.518918E-02       24      0.00000             0()
     5     0.566625E-05      0.275926E-05       21      0.00000             0()

-------------------------------------------------
'IME STEP       2 AT       2.00 DAYS
-------------------------------------------------
     .         .                 .                 .          .                .
     .         .                 .                 .          .                .
**********************************************
TOTAL RUN TIME:    6 MINUTES 15.59 SECONDS
**********************************************
```

Element Face Flow Output File Unit 43

This output file is generated when simulated flow at specified element faces are required to be printed. The element faces and aquifer layer numbers for which flow values are printed are specified by the user in print control file (Unit 10). The flow rates are printed in the units specified by the user in control input file (Unit 5) for every time step of the simulation period. All flow rates are reported as positive values. The element number into which the flow is directed is reported in parentheses next to the reported flow values. If the element face is located at the model boundary and the flow is towards outside of the model domain, then an element number of zero is reported.

```
*                                    ***************************************
*                                    *          ELEMENT FACE FLOW          *
*                                    *          (UNIT=ACRE-FEET )          *
*                                    ***************************************
*               LAYER          1                        1                        2
*                FACE     89-   90                 91-   90                 91-   90
*        TIME
     1.00 DAYS          0.00(into elem    65)      0.00(into elem    66)      0.00(into elem    66)
     2.00 DAYS          0.00(into elem    65)      0.00(into elem    66)      0.00(into elem    66)
     3.00 DAYS          0.00(into elem    65)      0.00(into elem    66)      0.00(into elem    66)
     4.00 DAYS          0.00(into elem    65)      0.00(into elem    66)      0.00(into elem    66)
     .                  .                          .                          .
     .                  .                          .                          .
     .                  .                          .                          .
  3588.00 DAYS          0.31(into elem    85)      0.43(into elem    86)      0.15(into elem    86)
  3589.00 DAYS          0.31(into elem    85)      0.43(into elem    86)      0.15(into elem    86)
  3590.00 DAYS          0.31(into elem    85)      0.43(into elem    86)      0.15(into elem    86)
  3591.00 DAYS          0.31(into elem    85)      0.44(into elem    86)      0.15(into elem    86)
  3592.00 DAYS          0.31(into elem    85)      0.44(into elem    86)      0.15(into elem    86)
  3593.00 DAYS          0.31(into elem    85)      0.44(into elem    86)      0.15(into elem    86)
  3594.00 DAYS          0.31(into elem    85)      0.44(into elem    86)      0.15(into elem    86)
  3595.00 DAYS          0.31(into elem    85)      0.44(into elem    86)      0.15(into elem    86)
  3596.00 DAYS          0.31(into elem    85)      0.44(into elem    86)      0.15(into elem    86)
  3597.00 DAYS          0.31(into elem    85)      0.44(into elem    86)      0.15(into elem    86)
  3598.00 DAYS          0.32(into elem    85)      0.44(into elem    86)      0.15(into elem    86)
  3599.00 DAYS          0.32(into elem    85)      0.44(into elem    86)      0.15(into elem    86)
  3600.00 DAYS          0.32(into elem    85)      0.44(into elem    86)      0.15(into elem    86)
```

Boundary Flux Output File Unit 44

This output file is generated when simulated flow at the groundwater boundary nodes are required to be printed. The groundwater node and aquifer layer numbers for which flow values are printed are specified by the user in print control file (Unit 10). The flow rates are printed in the units specified by the user in control input file (Unit 5) for every time step of the simulation period. A negative flow value represents outflow from the model area, and a positive value represents an inflow into the model area.

```
*                                        ****************************************
*                                        *            BOUNDARY FLUX             *
*                                        *          (UNIT=ACRE-FEET )           *
*                                        ****************************************
*                                        NOTE:THE INFLOW TO THE BASIN IS POSITIVE
*                LAYER      1           1           1
*                 NODE      1          22          43
*        TIME
     1.00 DAY(S)         -6.69      -13.37      -13.37
     2.00 DAY(S)         -6.50      -12.99      -12.99
     3.00 DAY(S)         -6.32      -12.64      -12.64
     4.00 DAY(S)         -6.15      -12.30      -12.30
     5.00 DAY(S)         -5.99      -11.98      -11.98
     6.00 DAY(S)         -5.84      -11.68      -11.68
     7.00 DAY(S)         -5.70      -11.40      -11.40
     8.00 DAY(S)         -5.57      -11.13      -11.13
     9.00 DAY(S)         -5.44      -10.87      -10.87
    10.00 DAY(S)         -5.32      -10.63      -10.63
    11.00 DAY(S)         -5.20      -10.40      -10.40
    12.00 DAY(S)         -5.09      -10.18      -10.18
    13.00 DAY(S)         -4.99       -9.97       -9.97
    14.00 DAY(S)         -4.89       -9.77       -9.77
    15.00 DAY(S)         -4.79       -9.58       -9.58
     .                    .           .           .
     .                    .           .           .
     .                    .           .           .
   351.00 DAY(S)         -2.70       -5.41       -5.43
   352.00 DAY(S)         -2.69       -5.39       -5.41
   353.00 DAY(S)         -2.68       -5.38       -5.39
   354.00 DAY(S)         -2.68       -5.36       -5.38
   355.00 DAY(S)         -2.67       -5.34       -5.36
   356.00 DAY(S)         -2.66       -5.33       -5.35
   357.00 DAY(S)         -2.65       -5.31       -5.33
   358.00 DAY(S)         -2.64       -5.30       -5.31
   359.00 DAY(S)         -2.64       -5.28       -5.30
   360.00 DAY(S)         -2.63       -5.26       -5.28
```

Tile Drain Hydrograph Output Unit 45

This output file is generated when simulated flow at the tile drains and/or subsurface irrigation locations are required to be printed. The corresponding groundwater node numbers for which flow values are printed are specified by the user in print control file (Unit 10). The flow rates are printed in the units specified by the user in control input file (Unit 5) for every time step of the simulation period. A negative flow value represents tile drain outflow at the specified groundwater node, and a positive value represents subsurface irrigation inflow.

```
*                                        ************************************************
*                                        *  TILE DRAIN/SUBSURFACE IRRIGATION HYDROGRAPH  *
*                                        *               (UNIT=AC.FT.DAY )               *
*                                        *       (+): SUBSURFACE IRRIGATION INFLOW       *
*                                        *       (-): TILE DRAIN OUTFLOW                 *
*                                        ************************************************
*                        NODES
*     TIME                 27          48
     1.00 DAY(S)        -13.52      -13.52
     2.00 DAY(S)        -13.28      -13.28
     3.00 DAY(S)        -13.05      -13.06
     4.00 DAY(S)        -12.84      -12.86
     5.00 DAY(S)        -12.64      -12.67
     6.00 DAY(S)        -12.45      -12.49
     7.00 DAY(S)        -12.28      -12.32
     8.00 DAY(S)        -12.11      -12.16
     9.00 DAY(S)        -11.96      -12.01
    10.00 DAY(S)        -11.81      -11.87
    11.00 DAY(S)        -11.67      -11.74
    12.00 DAY(S)        -11.53      -11.62
    13.00 DAY(S)        -11.41      -11.50
    14.00 DAY(S)        -11.28      -11.39
    15.00 DAY(S)        -11.17      -11.28
      .                   .           .
      .                   .           .
      .                   .           .
   351.00 DAY(S)         -7.49       -7.73
   352.00 DAY(S)         -7.48       -7.72
   353.00 DAY(S)         -7.48       -7.71
   354.00 DAY(S)         -7.47       -7.70
   355.00 DAY(S)         -7.46       -7.69
   356.00 DAY(S)         -7.45       -7.68
   357.00 DAY(S)         -7.44       -7.67
   358.00 DAY(S)         -7.43       -7.66
   359.00 DAY(S)         -7.42       -7.65
   360.00 DAY(S)         -7.41       -7.64
```

Stream Flow Hydrograph Output File Unit 46

The stream hydrograph output file can either contain stream flows or stream elevations, depending on the option set by the user in the print control file (Unit 10). The flow or elevation values are printed for the stream nodes specified by the user for each time step of the simulation period.

```
*                                    ****************************************
*                                    *          STREAM HYDROGRAPH           *
*                                    *          (UNIT=AC.FT.DAY )           *
*                                    ****************************************
*                        NODES
*     TIME                    1          2          3  .......         22          23
     1.00 DAY(S)         2053.09    2224.96    2430.53  .......   10316.80    10711.15
     2.00 DAY(S)         2005.36    2058.95    2123.99  .......    4583.00     4723.15
     3.00 DAY(S)         1993.28    2016.23    2044.01  .......    2906.39     2972.07
     4.00 DAY(S)         1990.13    2004.98    2022.64  .......    2398.28     2438.91
     5.00 DAY(S)         1989.24    2001.77    2016.45  .......    2231.60     2264.09
     6.00 DAY(S)         1988.91    2000.63    2014.22  .......    2167.81     2197.21
     7.00 DAY(S)         1988.73    2000.04    2013.05  .......    2136.10     2164.03
     8.00 DAY(S)         1988.59    1999.60    2012.18  .......    2115.22     2142.33
     9.00 DAY(S)         1988.47    1999.21    2011.41  .......    2097.59     2124.06
    10.00 DAY(S)         1988.35    1998.85    2010.70  .......    2080.65     2106.57
    11.00 DAY(S)         1988.25    1998.50    2010.03  .......    2064.71     2090.07
    12.00 DAY(S)         1988.14    1998.17    2009.39  .......    2049.69     2074.53
    13.00 DAY(S)         1988.04    1997.86    2008.78  .......    2035.44     2059.79
    14.00 DAY(S)         1987.95    1997.56    2008.20  .......    2023.19     2047.44
    15.00 DAY(S)         1987.86    1997.28    2007.64  .......    2009.36     2032.88
       .                    .          .          .     .......       .           .
       .                    .          .          .     .......       .           .
       .                    .          .          .     .......       .           .
   350.00 DAY(S)         1985.28    1989.81    1995.63  .......    1823.89     1836.40
   351.00 DAY(S)         1985.27    1989.80    1995.61  .......    1823.60     1836.10
   352.00 DAY(S)         1985.27    1989.78    1995.58  .......    1823.30     1835.79
   353.00 DAY(S)         1985.26    1989.76    1995.56  .......    1823.00     1835.48
   354.00 DAY(S)         1985.25    1989.74    1995.53  .......    1822.70     1835.17
   355.00 DAY(S)         1985.24    1989.73    1995.51  .......    1822.40     1834.86
   356.00 DAY(S)         1985.24    1989.71    1995.49  .......    1822.09     1834.54
   357.00 DAY(S)         1985.23    1989.69    1995.46  .......    1821.78     1834.22
   358.00 DAY(S)         1985.22    1989.68    1995.44  .......    1821.46     1833.90
   359.00 DAY(S)         1985.22    1989.66    1995.41  .......    1821.15     1833.58
   360.00 DAY(S)         1985.21    1989.64    1995.39  .......    1820.83     1833.25
```

Groundwater Level Hydrograph Output Unit 47

The groundwater level hydrograph output file includes the groundwater level at aquifer layers and nodes specified by the user in Unit 10. The layer and node numbers for which hydrographs are desired are specified by the user. If hydrographs at locations other than finite element nodes are desired, then IWFM prints out the element number where the x-y coordinate lies in. If groundwater head averaged over all the aquifer layers is desired, then a value of zero appears for the layer number at the heading of this file.

```
*                                    ****************************************
*                                    *       GROUNDWATER HYDROGRAPH         *
*                                    *          (UNIT=FEET      )           *
*                                    ****************************************
*               LAYER      1          1          1          1          1          1          1          1
*                NODE     76         77         98         97        140        141        161        162
*        TIME
     1.00 DAY(S)        280.83     308.80     308.82     281.87     309.30     309.98     309.35     309.98
     2.00 DAY(S)        272.18     307.45     307.51     273.70     308.45     309.94     308.54     309.94
     3.00 DAY(S)        269.61     306.11     306.20     271.27     307.58     309.87     307.73     309.88
     4.00 DAY(S)        268.84     304.82     304.95     270.42     306.75     309.78     306.94     309.79
     5.00 DAY(S)        268.55     303.60     303.76     270.11     305.95     309.67     306.19     309.69
     6.00 DAY(S)        268.43     302.44     302.64     269.99     305.19     309.55     305.48     309.58
     7.00 DAY(S)        268.36     301.34     301.57     269.94     304.47     309.42     304.80     309.45
     8.00 DAY(S)        268.32     300.30     300.56     269.90     303.79     309.27     304.15     309.31
     9.00 DAY(S)        268.29     299.32     299.61     269.87     303.14     309.11     303.54     309.16
    10.00 DAY(S)        268.26     298.38     298.70     269.85     302.52     308.94     302.96     309.00
    11.00 DAY(S)        268.23     297.49     297.83     269.83     301.93     308.76     302.40     308.83
    12.00 DAY(S)        268.20     296.65     297.01     269.80     301.37     308.57     301.87     308.65
    13.00 DAY(S)        268.17     295.84     296.23     269.78     300.83     308.38     301.37     308.47
    14.00 DAY(S)        268.15     295.08     295.49     269.76     300.32     308.19     300.89     308.29
    15.00 DAY(S)        268.12     294.35     294.78     269.74     299.82     307.99     300.42     308.10
      .                   .          .          .          .          .          .          .          .
      .                   .          .          .          .          .          .          .          .
      .                   .          .          .          .          .          .          .          .
   350.00 DAY(S)        267.84     285.49     289.29     269.67     316.12     330.31     317.58     331.29
   351.00 DAY(S)        267.84     285.49     289.29     269.67     316.13     330.33     317.59     331.31
   352.00 DAY(S)        267.84     285.50     289.30     269.67     316.14     330.36     317.61     331.33
   353.00 DAY(S)        267.84     285.50     289.31     269.67     316.15     330.38     317.62     331.36
   354.00 DAY(S)        267.84     285.51     289.32     269.67     316.16     330.40     317.63     331.38
   355.00 DAY(S)        267.84     285.51     289.33     269.67     316.17     330.42     317.64     331.40
   356.00 DAY(S)        267.84     285.52     289.33     269.67     316.18     330.44     317.65     331.42
   357.00 DAY(S)        267.84     285.52     289.34     269.67     316.19     330.46     317.66     331.45
   358.00 DAY(S)        267.84     285.52     289.35     269.67     316.20     330.48     317.67     331.47
   359.00 DAY(S)        267.84     285.53     289.35     269.67     316.21     330.50     317.68     331.49
   360.00 DAY(S)        267.84     285.53     289.36     269.67     316.22     330.52     317.69     331.51
```

Groundwater Level Output at Every Node Unit 48

This output file displays the groundwater levels at each groundwater node in every layer modeled. The beginning time step, ending time step and frequency of the output is specified in the Unit 5 input file. If the aquifer becomes dries at a ground water node, i.e. the groundwater head is equal to the elevation of the bottom of the aquifer at that node, then the elevation of the aquifer bottom is added 20000 and this value is printed out for that node. If a node is inactive, i.e. aquifer thickness becomes zero at that node, then the head at the above active node is added 40000 and this value is printed out for that node.

```
* TIME=      1.0 DAY(S)   LAYER=  1
     290.0     309.4     310.0     310.0     310.0     308.9     310.0     310.0     310.0     310.0
     310.0     309.1     277.7     309.1     310.2     310.0     310.0     310.0     310.0     310.0
     310.0     290.0     309.4     310.0     310.0     310.0     309.4     310.0     310.0     310.0
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
     290.0     309.4     310.0     310.0     310.0     308.9     310.0     310.0     310.0     310.0
     310.0     309.9     304.4     309.8     310.0     310.2     310.0     310.0     310.0     310.0
     310.0
* TIME=      2.0 DAY(S)   LAYER=  1
     290.0     308.9     310.0     310.0     309.9     307.9     309.9     310.0     310.0     310.0
     309.9     308.1     268.0     308.1     310.3     310.0     310.0     310.0     310.0     310.0
     310.0     290.0     308.9     310.0     310.0     309.9     308.9     309.9     310.0     310.0
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
     290.0     308.9     310.0     310.0     309.9     307.9     309.9     310.0     310.0     310.0
     310.0     309.8     303.0     309.6     310.0     310.4     310.0     310.0     310.0     310.0
     310.0
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
* TIME=    359.0 DAY(S)   LAYER=  1
     290.0     296.8     300.9     302.1     300.2     293.5     300.4     302.5     301.5     297.4
     289.9     278.8     262.6     281.9     297.4     305.6     312.7     317.8     321.2     323.2
     323.8     290.0     296.8     300.9     302.1     300.3     296.2     300.6     302.7     301.6
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
     290.0     290.7     291.0     290.6     289.5     286.8     291.9     295.2     297.8     299.7
     301.2     302.8     302.4     305.4     309.2     313.8     314.0     315.1     315.8     316.3
     316.5
* TIME=    360.0 DAY(S)   LAYER=  1
     290.0     296.8     300.9     302.0     300.2     293.5     300.4     302.5     301.5     297.4
     289.9     278.8     262.6     281.9     297.4     305.6     312.7     317.8     321.2     323.2
     323.8     290.0     296.8     300.9     302.1     300.3     296.1     300.6     302.6     301.6
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
       .         .         .         .         .         .         .         .         .         .
     290.0     290.7     290.9     290.6     289.5     286.7     291.8     295.2     297.8     299.7
     301.2     302.8     302.4     305.4     309.2     313.8     314.0     315.1     315.9     316.3
     316.5
```

Layer Vertical Flow Output File Unit 49

This output file lists the vertical flow between aquifer layers at each subregion for multi-layered aquifer systems. The values listed in this file are vertical flows between an aquifer layer and the upper adjacent layer at every time step of the simulation period. A negative value represents downward flow direction, whereas a positive value represents upward flow direction.

```
*                                  ************************************
*                                  *   VERTICAL FLOW IN ACRE-FEET     *
*                                  *  (POSITIVE IN UPWARD DIRECTION)  *
*                                  ************************************
*       REGION            1                    2  .......        20                  21
*        LAYER            2           3        2  .......         2          3        2          3
* TIME (day)
        1.00        -741.36      110.75      712.68  .......  -4968.98       59.44  -5928.82    -477.26
        2.00        -632.06      101.74     1065.13  .......  -4861.09       87.99  -5079.35    -664.08
        3.00        -512.96       92.07     1655.39  .......  -4761.83      115.34  -4452.26    -790.68
        4.00        -408.56       84.21     1789.70  .......  -4670.02      141.19  -3949.41    -887.29
        5.00        -318.04       78.03     1864.07  .......  -4584.50      165.37  -3532.08    -963.95
        6.00        -239.57       73.32     1917.93  .......  -4504.39      187.77  -3180.98   -1025.18
        7.00        -171.51       69.84     1962.89  .......  -4428.87      208.36  -2883.18   -1073.80
        8.00        -113.27       67.40     2002.18  .......  -4357.33      227.16  -2628.92   -1111.90
        9.00         -62.50       65.85     2036.47  .......  -4289.29      244.20  -2410.60   -1141.20
       10.00         -22.69       65.02     2069.94  .......  -4224.31      259.55  -2222.22   -1163.26
       11.00          13.80       64.80     2512.63  .......  -4162.05      273.28  -2058.75   -1179.17
       12.00          45.45       65.07     2460.50  .......  -4102.23      285.50  -1916.11   -1189.99
       13.00          72.93       65.74     2464.26  .......  -4044.60      296.29  -1790.95   -1196.58
       14.00          96.54       66.73     2477.91  .......  -3988.94      305.74  -1680.49   -1199.67
       15.00         114.46       68.03     2492.57  .......  -3935.10      313.96  -1582.44   -1199.85
       16.00         127.55       69.50     2505.90  .......  -3882.92      321.03  -1494.91   -1197.63
       17.00         140.66       71.09     2516.60  .......  -3832.27      327.05  -1420.17   -1193.42
       18.00         151.48       72.80     2526.72  .......  -3783.04      332.10  -1351.51   -1187.57
       19.00         157.64       74.69     2539.55  .......  -3735.14      336.27  -1289.30   -1180.36
       20.00         164.18       76.49     2969.94  .......  -3688.49      339.63  -1232.60   -1172.05
       21.00         169.88       78.31     2868.27  .......  -3643.01      342.25  -1180.64   -1162.84
       22.00         174.37       80.14     2849.04  .......  -3598.75      344.20  -1132.77   -1152.88
       23.00         178.41       81.96     2844.34  .......  -3555.51      345.55  -1088.44   -1142.33
       24.00         181.88       83.76     2843.82  .......  -3513.29      346.35  -1047.19   -1131.30
       25.00         184.08       85.52     2843.72  .......  -3472.02      346.65  -1008.53   -1119.89
       26.00         186.23       87.25     2842.66  .......  -3431.66      346.50   -972.23   -1108.18
       27.00         188.06       88.95     2841.66  .......  -2656.11      345.95   -938.00   -1096.24
       28.00         189.09       90.60     2840.44  .......  -2832.23      345.05   -905.59   -1084.14
       29.00         188.46       92.38     2838.95  .......  -2832.45      343.81   -874.82   -1071.92
       30.00         189.19       93.93     2837.10  .......  -1857.32      342.29   -845.51   -1059.62
```

Final Simulation Results Unit 50

This file lists the simulation results at the end of the simulation period. It is in a format that can readily be used as initial conditions data file (Unit 11) for following simulation periods. For instance, consider an initial IWFM run performed for a simulation period that starts at January 1, 1973 and ends at December 31, 1992. Final simulation results output file will include all simulation results at the end of December 31, 1992. To perform a second IWFM run for a simulation period that starts at January 1, 1993 file Unit 50 can be used as an initial conditions data file. Similar to the groundwater head output at every node (Unit 48), 20000 is used as a flag at dry nodes and 40000 is used as a flag for inactive nodes in reporting the final groundwater heads. The interbed thickness and pre-consolidation head values at inactive nodes are printed as 9999.000.

```
C*************************************************************************
C ***** SIMULATION RESULTS AT TIME     30.00 day
C*************************************************************************
C
C ***** GROUNDWATER HEAD VALUES
C*************************************************************************
C   LAYER   1
C*************************************************************************
   1.000000
  20605.0000000000         20605.0000000000         621.900070329929   .....    432.813026771975         496.650645102
  387.571617077423         535.472525889578         770.051718188966   .....    715.004537846308         20720.0000000
  20520.0000000000         395.571091712471         375.646444448531   .....    366.185587858368         20465.0000000
  .                        .                        .                  .....    .                        .
  .                        .                        .                  .....    .                        .
  .                        .                        .                  .....    .                        .
  21300.0000000000         555.566649143294         450.171865581857   .....    421.932037799460         486.146185556
  20874.0000000000         1712.64559618794         668.013419073559   .....    845.969382110627         1421.91085976
  1027.94758321902         1330.14175314542         1434.54721746164
C*************************************************************************
C   LAYER   2
C*************************************************************************
   1.000000
  20555.0000000000         594.268212596875         621.825955555383   .....   433.552481435639         495.7807189708
  387.778092011510         491.217612864044         722.992952744224   .....   667.187888489437         670.9031509164
  458.879924305839         396.186699354260         376.254030997574   .....   366.524325678366         401.6651417534
  .                        .                        .                  .....   .                        .
  .                        .                        .                  .....   .                        .
  .                        .                        .                  .....   .                        .
  1127.85314443836         537.429105064827         455.516111277596   .....   426.995184810763         487.1666262329
  20724.0000000000         41712.6455961879         644.725948978744   .....   40845.9693821106         41421.91085976
  41027.9475832190         41330.1417531454         41434.5472174616
C*************************************************************************
C   LAYER   3
C*************************************************************************
   1.000000
  40555.0000000000         40594.2682125969         40621.8259555554   .....   440.557604278229         487.7849858411
  40387.7780920115         40491.2176128640         40722.9929527442   .....   40667.1878884894         536.1895471903
  452.576852795560         403.915656756026         381.457930854301   .....   370.616199540561         40401.66514175
  .                        .                        .                  .....   .                        .
  .                        .                        .                  .....   .                        .
  .                        .                        .                  .....   .                        .
  41127.8531444384         492.965764857591         446.602927522595   .....   483.122301861706         515.4349897570
  445.701134285053         41712.6455961879         532.372134681844   .....   40845.9693821106         41421.91085976
  41027.9475832190         41330.1417531454         41434.5472174616
C ***** ROOT ZONE SOIL MOISTURE AS VOLUME
   1.000000
     1    0.00000000000000       576993.054209681      51816807.0818276  .....     0.00000000000000      0.00000000000
     2    0.00000000000000       82028734.2920410      200045703.883344  .....     0.00000000000000      0.00000000000
     3    0.00000000000000       0.00000000000000      11299314.5423792  .....     0.00000000000000      0.00000000000
     .    .                      .                     .                 .....     .                     .
     .    .                      .                     .                 .....     .                     .
     .    .                      .                     .                 .....     .                     .
    20    0.00000000000000       241001824.706734      45783364.4073317  .....     0.00000000000000      0.00000000000
    21    0.00000000000000       484531638.526806      100058074.937437  .....     0.00000000000000      0.00000000000
C ***** UNSATURATED ZONE SOIL MOISTURE AS A FRACTION OF TOTAL POROSITY
   1.000000
     1   4.438889455363878E-003   2.556338171906956E-010
     2    0.00000000000000         0.00000000000000
     3    0.00000000000000         0.00000000000000
     .    .                        .
     .    .                        .
     .    .                        .
  1390    0.00000000000000         0.00000000000000
  1391    0.00000000000000         0.00000000000000
  1392    0.00000000000000         0.00000000000000
C ***** SMALL WATERSHED SOIL MOISTURE AND GROUNDWATER STORAGE
   1.000000
     1   0.260192828355463         9.41707953957551
     2   1.412475353929657E-002    9.41707953957551
     3   5.451659260781131E-003    9.41707953957551
     .   .                         .
     .   .                         .
     .   .                         .
    14   0.128745815483066         9.41707953957551
    15   1.300964141777316E-002    9.41707953957551
C ***** LAKE ELEVATIONS
   1.000000
  1    281.962865162222
  2    184.611099679168
C ***** INTERBED THICKNESS
C*************************************************************************
C   LAYER   1
C*************************************************************************
```

```
   1.000000
  12.9999393802902       11.9999382525607      11.9999503238972   .....    14.0001551715175      10.9998228233117
  21.9999595701265       25.9999757255399      22.9999401479066   .....     7.99997640339434      7.99997528206760
  7.99997291208803       8.00007203961515      13.0000658971613   .....     8.00002900121345      10.9999627496099
  .                      .                     .                  .....     .                     .
  .                      .                     .                  .....     .                     .
  .                      .                     .                  .....     .                     .
  6.99978170442880       0.00000000000000      6.00000464037244   .....    18.0000754952138      33.9999137364433
  16.9992171481959       32.9995389991466      100.239832534616   .....    81.0067651678598      65.0218038106907
  65.0062327569299       63.0051292138376      63.0061939804593
C*******************************************************************************
C   LAYER   2
C*******************************************************************************
   1.000000
  3.99999134628982       4.00000554782836      4.00002368708255   .....    4.00001084456937      2.99996153491550
  4.99989038233091       5.00005012153220      5.00002076647771   .....    5.00006692749269      4.99998409591728
  8.99987728273730       9.00003145623023      9.99997993124233   .....    9.99994079452986      10.0000074313797
  .                      .                     .                  .....    .                     .
  .                      .                     .                  .....    .                     .
  .                      .                     .                  .....    .                     .
  10.0012534674304       7.00177363467500      10.0005020371667   .....   14.9996750020413      10.0018201664987
  34.9992226881236       0.00000000000000      135.086761953138   .....    0.00000000000000      0.00000000000000
  0.00000000000000       0.00000000000000      0.00000000000000
C*******************************************************************************
C   LAYER   3
C*******************************************************************************
   1.000000
  0.00000000000000       0.00000000000000      0.00000000000000   .....    0.00000000000000      0.00000000000000
  0.00000000000000       0.00000000000000      0.00000000000000   .....    0.00000000000000      0.00000000000000
  0.00000000000000       0.00000000000000      0.00000000000000   .....    0.00000000000000      0.00000000000000
  .                      .                     .                  .....    .                     .
  .                      .                     .                  .....    .                     .
  .                      .                     .                  .....    .                     .
  0.00000000000000       0.00000000000000      0.00000000000000   .....    0.00000000000000      0.00000000000000
  0.00000000000000       0.00000000000000      0.00000000000000   .....    0.00000000000000      0.00000000000000
  0.00000000000000       0.00000000000000      0.00000000000000
C ***** PRECONSOLIDATION HEAD VALUES
C*******************************************************************************
C   LAYER   1
C*******************************************************************************
   1.000000
  506.000000000000         506.000000000000         523.000000000000   .....     330.000000000000         400.00000000
  288.000000000000         436.000000000000         671.000000000000   .....     616.000000000000         621.00000000
  421.000000000000         294.000000000000         275.000000000000   .....     265.000000000000         366.00000000
  .                        .                        .                  .....     .                        .
  .                        .                        .                  .....     .                        .
  .                        .                        .                  .....     .                        .
  750.000000000000         555.566649143294         450.000000000000   .....     280.000000000000         340.00000000
  750.000000000000         750.000000000000         668.013419073559   .....     750.000000000000         750.00000000
  750.000000000000         750.000000000000         750.000000000000
C*******************************************************************************
C   LAYER   2
C*******************************************************************************
   1.000000
  455.000000000000         494.000000000000         521.000000000000   .....     333.000000000000         399.00000000
  293.000000000000         389.000000000000         622.000000000000   .....     567.000000000000         572.00000000
  362.000000000000         295.000000000000         277.000000000000   .....     268.000000000000         302.00000000
  .                        .                        .                  .....     .                        .
  .                        .                        .                  .....     .                        .
  .                        .                        .                  .....     .                        .
  750.000000000000         431.000000000000         404.000000000000   .....     280.000000000000         340.00000000
  407.000000000000         9999.00000000000         452.000000000000   .....     9999.00000000000         9999.0000000
  9999.00000000000         9999.00000000000         9999.00000000000
C*******************************************************************************
C   LAYER   3
C*******************************************************************************
   1.000000
  9999.00000000000         9999.00000000000         9999.00000000000   .....     339.000000000000         395.00000000
  9999.00000000000         9999.00000000000         9999.00000000000   .....     9999.00000000000         441.00000000
  359.000000000000         300.000000000000         282.000000000000   .....     274.000000000000         9999.0000000
  .                        .                        .                  .....     .                        .
  .                        .                        .                  .....     .                        .
  .                        .                        .                  .....     .                        .
  9999.00000000000         480.459285073626         442.320792394920   .....     280.000000000000         340.00000000
  445.000000000000         9999.00000000000         497.860000000000   .....     9999.00000000000         9999.0000000
  9999.00000000000         9999.00000000000         9999.00000000000
```

Binary Output Files

The binary files contain the simulation results and they are used in the post-processing portion (Budget and Z-Budget) of IWFM in order to generate detailed water budget tables for modeled hydrologic processes. The files are generated in the simulation program, and must be copied to the folder with the IWFM Budget and Z-Budget executable programs. The binary files that can be generated are

- Binary output for groundwater zone budget (Unit 31)
- Binary output for small watershed flow components (Unit 32)
- Binary output for element sub-group details (Unit 33)
- Binary output for diversion details (Unit 34)
- Binary output for stream budget by reach (Unit 35)
- Binary output for lake budget (Unit 36)
- Binary output for land and water use budget (Unit 37)
- Binary output for stream budget (Unit 38)
- Binary output for root zone moisture budget (Unit 39)
- Binary output for groundwater budget (Unit 40)

4. Budget

The budget program tabulates the simulation output, allowing the user to generate the following tables based on output files created in the Simulation part of IWFM: land and water use, stream flows, root zone moisture accounting, groundwater, element sub-group accounting, small watersheds, lakes, stream reaches and diversion details. This chapter describes the input and output files, as well as providing input and output file samples.

4.1. Input Files

The main input file and at least one of the binary output files generated during IWFM simulation is required to run the budget program. The binary files contain results produced from the simulation of IWFM. A list of the simulation output unit numbers, corresponding budget input unit numbers and file descriptions are given in Table 4.1. The simulation output unit numbers are specified in the main simulation input file (Unit 5) and the budget input unit numbers are listed in the main budget input file. The file names are variable, depending on user specification. However, the file names for binary output from the simulation program must be the same as the binary input file names specified in the main budget input file.

Simulation output	Budget input	Description
Unit 37	Unit 1	Land and water use simulation output
Unit 38	Unit 2	Simulated stream flow output
Unit 39	Unit 3	Root zone moisture accounting output
Unit 40	Unit 4	Simulated groundwater output
Unit 33	Unit 5	Element sub-group accounting output
Unit 32	Unit 6	Small watershed boundary condition output
Unit 36	Unit 7	Lake simulation output
Unit 35	Unit 8	Stream reach output
Unit 34	Unit 9	Diversion detail output

Table 4.1 Unit numbers for binary simulation output and budget input

Main Input File

The main input file contains names of the binary files generated in the simulation part of IWFM, output unit controls, beginning and ending time step as well as the frequency that the budget information is reported. The values stored in the binary files have units used in the simulation. Each budget table begins with time step ITBEGIN, ends with ITLAST, and provides all time intervals within this range based on the frequency (MPRNT).

The user must specify the number of subregions modeled in IWFM simulation, the name of each subregion modeled and the printing option for each subregion. To print the budget information for a subregion, the print switch value (IPRINT) is set to any

value other than zero. If budget information for a subregion is not to be printed, the print switch must be set to zero. The budget information for the entire model domain is printed always. The following is a list of variables that need to be defined in this input file:

FACTLTOU	Factor to convert simulation unit of length to output unit of length
UNITLTOU	Output unit of length (maximum of 8 characters)
FACTAROU	Factor to convert simulation unit of area to output unit of area
UNITAROU	Output unit of area (maximum of 8 characters)
FACTVLOU	Factor to convert simulation unit of volume to output unit of volume
UNITVLOU	Output unit of volume (maximum of 8 characters)
ITBEGIN	Beginning time step for the budget tables
ITLAST	Ending time step for the budget tables
MPRNT	Frequency of budget output
NREGN	Number of subregions modeled in IWFM simulation
IR	Subregion number
IPRINT	Budget print option (enter zero to depress budget printing for a subregion)
NAME	Subregion name

```
C*******************************************************************************
C
C                  INTEGRATED WATER FLOW MODEL (IWFM)
C                         *** Version ### ***
C
C*******************************************************************************
C
C                          BUDGET INPUT FILE
C                       for IWFM Post-Processing
C
C
C             Project:  IWFM Version ### Release
C                       California Department of Water Resources
C             Filename: BUDGET.IN
C
C*******************************************************************************
C
C                             File Description
C
C    This file contains the the names and descriptions of all binary input files,
C    conversion factors and output control options for running the post-processor.
C
C*******************************************************************************
C                      Input File Names
C    The following is a list of the input binary files for the generation of
C    budget tables.
C
C   *If a file does not exist for a project, leave the filename blank
C    For example, if stream flow budget is not desired, the file name and
C    description columns for unit 2 will appear as:
C
C    FILE NAME                          UNIT DESCRIPTION
C                                       / 2: BINARY FILE GENERATED BY SIMULATION FOR STREAMFLOW BUDGET
C-------------------------------------------------------------------
C    FILE NAME                          UNIT DESCRIPTION
C-------------------------------------------------------------------
  LWU.BIN                              / 1: BINARY FILE GENERATED BY SIMULATION FOR LAND AND WATER USE BUDGET
  STRM.BIN                             / 2: BINARY FILE GENERATED BY SIMULATION FOR STREAMFLOW BUDGET
  SOIL.BIN                             / 3: BINARY FILE GENERATED BY SIMULATION FOR ROOT ZONE MOISTURE BUDGET
  GW.BIN                               / 4: BINARY FILE GENERATED BY SIMULATION FOR GROUNDWATER BUDGET
  SUBGRP.BIN                           / 5: BINARY FILE GENERATED BY SIMULATION FOR ELEMENT SUB-GROUP DETAILS
  SMWSHED.BIN                          / 6: BINARY FILE GENERATED BY SIMULATION FOR SMALL WATERSHED FLOW COMPONENTS
  LAKE.BIN                             / 7: BINARY FILE GENERATED BY SIMULATION FOR LAKE BUDGET
  REACH.BIN                            / 8: BINARY FILE GENERATED BY SIMULATION FOR STREAM BUDGET BY REACH
  DIVERDTL.BIN                         / 9: BINARY FILE GENERATED BY SIMULATION FOR DIVERSION DETAILS
C*******************************************************************************
C                     Output Unit Control
C
C    FACTLTOU; Factor to convert simulation unit of length to output unit of length
C    UNITLTOU; Output unit of length (8 characters max.)
C    FACTAROU; Factor to convert simulation unit of area to output unit of area
C    UNITAROU; Output unit of area (8 characters max.)
C    FACTVLOU; Factor to convert simulation unit of volume to output unit of volume
C    UNITVLOU; Output unit of volume (8 characters max.)
C
C-------------------------------------------------------------------------------
C VALUE                            DESCRIPTION
C-------------------------------------------------------------------------------
    1.0                            / FACTLTOU
    FEET                           / UNITLTOU
    0.000022957                    / FACTAROU
    ACRES                          / UNITAROU
    0.000022957                    / FACTVLOU
    AC.FT.                         / UNITVLOU
C*******************************************************************************
C                      Budget Output Control Options
C
C    ITBEGIN; Begining time step for the budget tables
C    ITLAST ; Ending time step for the budget tables
C    MPRNT  ; Frequency of budget output
C-------------------------------------------------------------------------------
C   VALUE                          DESCRIPTION
C-------------------------------------------------------------------------------
    1                              / ITBEGIN
    3600                           / ITLAST
    1                              / MPRNT
C*******************************************************************************
C                           Subregion Names and Print Options
C
C   The following lists the subregion names (maximum 20 characters long) and
C   the option to generate a budget table for a subregion.
C
C   NREGN ; Number of subregions modeled
C   IR    ; Subregion number
C   IPRINT; Budget print option (enter 0 to depress budget print out for a subregion)
C   NAME  ; Name of subregion
C
C-------------------------------------------------------------------------------
C   VALUE                          DESCRIPTION
C-------------------------------------------------------------------------------
     2                             / NREGN
C-------------------------------------------------------------------------------
C  IR    IPRINT          NAME
C-------------------------------------------------------------------------------
   1      1              REGION 1
   2      1              REGION 2
```

Binary Input Files

The budget program binary input files are created during IWFM simulation. The binary files generated for post-processing are specified by the user in the IWFM simulation main input file (Unit 5). As few as one and as many as nine binary files can be input for processing IWFM output in tabular form. All binary files must be specified in the main budget input file. Refer to Table 4.1 for a list of unit numbers that correspond with the binary input files.

4.2. Output Files

The budget program generates up to nine output files. More specifically, an output file is generated for each binary input file provided by the user. The output file names are the same with the names of binary files except that their extension names are replaced with "BUD". For instance, if the lake budget binary file is named as LAKE.BIN, the output file name after running budget program will be LAKE.BUD. The output files include information generated by IWFM simulation. All output files organized by subregion include a table for each subregion specified for printing in the main input file, as well as the total modeled area. The other output files are organized by element sub-group, small watershed, lake or stream reach. The beginning time step, ending time step and frequency of each output file is based on the values of ITBEGIN, ITLAST and MPRNT specified in the main budget input file. Therefore, each budget

table ranges from time step ITBEGIN to ITLAST and the values are accumulated and written for every time interval (MPRNT) within the output time range.

Land and Water Use Budget Unit 1

The land and water use budget is organized by subregion. A budget table is produced for each subregion specified for printing in the main input file, as well as the total modeled area. The title printed for each subregional land and water use budget includes IWFM version number, subregion name given by the user, the unit of data columns and the area of the subregion. For example, all land and water use budget columns are in volumetric units except *Time*, *Agricultural Area* and *Urban Area*. The output units and conversion factors for area (UNITAROU and FACTAROU) and volume (UNITVLOU and FACTVLOU) are specified by the user in the main budget input file.

The total agricultural and urban areas, as well as the potential consumptive use of applied water are reported in the output, followed by the components that the land and water use budget is comprised of. A positive or negative sign is given for each column that is a component of the subregional mass balance. The *Shortage* column is the resulting balance, based on water use components. A value of zero in this column indicates that the available water supply (surface water diversions and groundwater pumping) meets the agricultural or urban supply requirements. A positive value indicates that the supply is not a large enough quantity to satisfy water requirements. Conversely, a negative value in the *Shortage* column signifies a water supply surplus. The amount of return flow that is re-used in agricultural and urban areas is also listed. In the last two

columns, total water imports to and exports from the subregion are listed. The following table defines each column in the land and water use budget table and lists the variable(s) associated with each column as represented in the IWFM code:

LAND AND WATER USE BUDGET

COL. #	COLUMN NAME	VARIABLE	DESCRIPTION
1	Time	IFLAG	Time step
Agricultural Area			
2	Area	RLAND(IRL+1)	Agricultural area
3	Potential CUAW	RCUAW	Applied water needed for optimum agricultural conditions where adequate crop production is guaranteed by maintaining ET rates at their potential levels, soil moisture losses to deep percolation are minimized, and the minimum soil moisture requirements are met at all times
4	Agricultural Supply Requirement	RDMAG	Amount of water necessary to meet the agricultural demand that is either computed internally or specified by the user in the Unit 19 simulation input file
5	Pumping (-)	RPUMP_AG	Portion of groundwater pumping that is used to meet the agricultural supply requirement
6	Diversion (-)	RDELI_AG	Portion of the actual amount of water diverted from streams that is used to meet the agricultural supply requirement
7	Shortage (=)	RDMSH_AG	Resulting water balance with respect to the agricultural supply requirements and supply specified in preceding columns
8	Re-use	RUW_AG	Amount of return flow that is re-used in agricultural areas
Urban Area			
9	Area	RLAND(IRL+2)	Urban area
10	Urban Supply Requirement	RDMUR	User specified indoor and outdoor urban demand
11	Pumping (-)	RPUMP_URB	Portion of groundwater pumping that is used to meet the urban supply requirement

12	Diversion (-)	RDELI_URB	Portion of the actual amount of water diverted from streams that is used to meet the urban supply requirement
13	Shortage (=)	RDMSH_URB	Resulting water balance with respect to the urban supply requirements and supply specified in preceding columns
14	Re-use	RUW_URB	Amount of return flow that is re-used in urban areas
Region Imports/Exports			
15	Import	RDVIM+RPUMPIM	Amount of water imported into a subregion from either another subregion, or from outside the modeled area
16	Export	RDVEX+RPUMPEX	Amount of water exported from subregion to either another subregion, or outside the modeled area

Stream Flow Budget Unit 2

Stream flow budgets are generated for all subregions specified to be printed in the main input file and the total modeled area. The title printed for each subregional stream flow budget includes IWFM version number, subregion name given by the user, the unit of data columns and the area of the subregion. The entire stream flow budget is in volumetric units. The output units (UNITVLOU) and conversion factor (FACTVLOU) for volume are specified by the user in the main budget input file.

The stream flow budget tables provide information on the flows in and out of the subregion as well as the impacts of other processes on stream flows within a subregion such as small stream watershed flows, tile drainage, surface runoff, return flows, diversions and bypass flows. Based on stream inflows to the subregion and other processes occurring within the subregion, the stream flow amount leaving the subregion is reported (*Downstream Outflow*). The *Diversion Shortage* column reports the difference between simulated diversions and the user specified diversion requirements.

The following table defines each column in the stream flow budget and specifies the corresponding variable in the IWFM code:

STREAM FLOW BUDGET

COL. #	COLUMN NAME	VARIABLE	DESCRIPTION
1	Time	IFLAG	Time step
2	Upstream Inflow (+)	RUFLOW	Stream inflows to a subregion, which includes inflows from Unit 21 and flows from upstream reaches located in other subregions
3	Downstream Outflow (-)	RDFLOW	Stream flows leaving the subregion and either entering another subregion, or exiting the modeled area
4	Tributary Inflow (+)	RTRIB	Surface flows from small stream watersheds to the streams
5	Tile Drain (+)	RSTDRAIN	Inflows from tile drains
6	Runoff (+)	RROST	Direct runoff from rainfall into the streams
7	Return Flow (+)	RRTST	Return flow of the irrigation water into streams
8	Gain from Groundwater (+)	-RSTINF	Stream-groundwater interaction; a positive value denotes a gaining stream and a negative value indicates a losing stream
9	Gain from Lake (+)	RRLKIN	Inflow from upstream lakes
10	Diversion (-)	RDIVS	Diversions from the streams
11	Bypass Flow (-)	RBYPS	Net bypass flow within a subregion; for example, the bypass flow from one stream node to another within the subregion is the amount of water loss during the bypass process whereas bypass flow from a stream node in the subregion to a different subregion is the total amount bypassed from the stream node
12	Discrepancy (=)	RSERR	Error in the stream flow mass balance based on the preceding columns

13	Diversion Shortage	RDVSH	This column indicates whether the simulated stream flows are sufficient to meet the surface water diversion requirements; a value of zero indicates that stream flows are sufficient to meet the specified diversion requirements; a positive value represents the shortage of stream flow in a subregion

Root Zone Moisture Budget Unit 3

The root zone moisture budget is organized by subregion. A table is produced for each subregion specified for printing in the main input file, as well as the total modeled area. The title printed for each subregional root zone moisture budget includes IWFM version number, subregion name given by the user, the unit of data columns and the area of the subregion. The output units are specified by the user in the main budget input file.

The root zone moisture budget provides information on processes that are used to compute soil moisture in the root zone. Agricultural areas represent the areas where crops are located. Urban area includes indoor and outdoor urban areas and the native and riparian lands represent the undeveloped area in the subregion. For each area type (agricultural, municipal, and native and riparian vegetation), precipitation and irrigation (except for native and riparian vegetation areas) along with direct runoff and return flows are listed. The infiltration column is computed by adding the precipitation and prime irrigation water and subtracting the runoff and return flow. The following table describes the columns in the root zone moisture budget:

ROOT ZONE MOISTURE BUDGET

COL. #	COLUMN NAME	VARIABLE	DESCRIPTION
1	Time	IFLAG	Time step
Agricultural Area			
2	Area	RLAND(IRAG)	Agricultural area
3	Precipitation	RRAIN(IRAG)*RLAND(IRAG)	Precipitation that falls on agricultural lands
4	Runoff	RROFF(IRAG)	Direct runoff of precipitation that falls on agricultural lands
5	Prime Applied Water	RDELI_AG+ RPUMP_AG	Amount of water applied for irrigation purposes excluding the re-used return flow; the time-series fraction of surface water diversions and pumping specified for irrigation purposes is located in Unit 27 of simulation
6	Reused Water	RUW_AG	The amount of re-used water on agricultural lands
7	Total Applied Water	RDELI_AG + RPUMP_AG + RUW_AG	Total irrigation water as a summation of prime applied water and the re-used water on agricultural lands
8	Return Flow	RRTRN(IRAG)	Net return flow of irrigation on agricultural lands (after re-use)
9	Beginning Storage	RSOILM_P(IRAG)	Root zone moisture in agricultural lands at the beginning of time step
10	Net Gain from Land Expansion (+)	RSOILMCH(IRAG)	The net moisture gained from other land use areas as the area of agricultural lands increase (a negative value represents loss of moisture due to the decrease of agricultural area)
11	Infiltration (+)	RINFILT(IRAG)	Total infiltration on the agricultural lands; computed as the summation of precipitation and applied water less runoff and return flow
12	Actual ET (–)	RETAC(IRAG)	Actual evapotranspiration in agricultural lands, which is computed based on ET rates under standard conditions in Unit 16 of simulation and root zone moisture values

13	Deep Percolation (–)	RPERC(IRAG)	Deep percolation from the root zone to the unsaturated zone in agricultural areas
14	Ending Storage (=)	RSOILM(IRAG)	Root zone moisture in agricultural lands at the end of the time step; computed as the summation of the beginning storage and infiltration less actual ET and deep percolation
Urban Area			
15	Area	RLAND(IRURB)	Urban area
16	Precipitation	RRAIN(IRURB)*RLAND(IRURB)	Precipitation that falls on urban lands
17	Runoff	RROFF(IRURB)	Direct runoff of precipitation that falls on urban lands
18	Prime Applied Water	RDELI_URB+ RPUMP_URB	Amount of water used for urban indoors and outdoors usage; this is the amount of water before the re-use of return flow is considered
19	Reused Water	RUW_URB	The amount of re-used water on urban lands
20	Total Applied Water	RDELI_URB + RPUMP_URB + RUW_URB	Total applied water as a summation of prime applied water and the re-used water on urban lands
21	Return Flow	RRTRN(IRURB)	Net return flow of applied water used for urban indoors and outdoors usage (after re-use)
22	Beginning Storage	RSOILM_P(IRURB)	Root zone moisture at the beginning of time step
23	Net Gain from Land Expansion (+)	RSOILMCH(IRURB)	The net moisture gained from other land use areas as the area of urban lands increase (a negative value represents loss of moisture due to the decrease of urban area)
24	Infiltration (+)	RINFILT(IRURB)	Total infiltration on the urban lands; computed as the summation of precipitation and applied water less runoff and return flow

25	Actual ET (–)	RETAC(IRURB)	Actual evapotranspiration in urban lands, which is computed based on ET rates under standard conditions in Unit 16 of simulation and root zone moisture values
26	Deep Percolation (–)	RPERC(IRURB)	Deep percolation from the root zone to the unsaturated zone in urban areas
27	Ending Storage (=)	RSOILM(IRURB)	Root zone moisture in urban lands at the end of the time step; computed as the summation of the beginning storage and infiltration less actual ET and deep percolation
Native & Riparian Vegetation			
28	Area	RLAND(IRNV)+RLAND(IRRV)	Native and riparian vegetation area
29	Precipitation	RRAIN(IRNV)*RLAND(IRNV)+ RRAIN(IRRV)*RLAND(IRRV)	Precipitation that falls on areas with natiave and riparian vegetation
30	Runoff	RROFF(IRNV)+RROFF(IRRV)	Direct runoff of precipitation that falls on areas with native and riparian vegetation
31	Beginning Storage	RSOILM_P(IRNV)+ RSOILM_P(IRRV)	Root zone moisture in areas with native and riparian vegetation at the beginning of time step
32	Net Gain from Land Expansion (+)	RSOILMCH(IRNV)+ RSOILMCH(IRRV)	The net moisture gained from other land use areas as the area of native and riparian vegetation increase (a negative value represents loss of moisture due to the decrease of native and riparian vegetation area)
33	Infiltration (+)	RINFILT(IRNV)+RINFILT(IRRV)	Total infiltration on areas with native and riparian vegetation; computed as precipitation less runoff
34	Actual ET (–)	RETAC(IRNV)+RETAC(IRRV)	Actual evapotranspiration in areas with native and riparian vegetation, which is computed based on ET rates under standard conditions in Unit 16 of simulation and root zone moisture values
35	Deep Percolation (–)	RPERC(IRNV)+RPERC(IRRV)	Deep percolation from the root zone to the unsaturated zone in areas with native and riparian vegetation

36	Ending Storage (=)	RSOILM(IRNV)+RSOILM(IRRV)	Root zone moisture in areas with native and riparian vegetation at the end of the time step; computed as the summation of the beginning storage and infiltration less actual ET and deep percolation

Groundwater Budget Unit 4

A groundwater budget table is produced for each subregion specified for printing in the main input file, as well as the total modeled area. The title printed for each subregional groundwater budget includes IWFM version number, subregion name given by the user, the unit of data columns and the area of the subregion. The output units and the conversion factors are specified by the user in the main budget input file.

The groundwater budget reports the inflows and outflows as well as the beginning and ending groundwater storages. The deep percolation of water from the root zone to the unsaturated zone to compare to the net deep percolation into the groundwater and the cumulative subsidence are also reported. The following list describes the columns in the groundwater budget table:

GROUNDWATER BUDGET

COL. #	COLUMN NAME	VARIABLE	DESCRIPTION
1	Time	IFLAG	Time step
2	Deep Percolation	RPERCE	Total deep percolation from the root zone to the unsaturated zone in a subregion; this column is included to compare deep percolation to net deep percolation and is not included in the groundwater mass balance
3	Beginning Storage (+)	RGWSTP	Groundwater storage at the beginning of the time step

4	Ending Storage (–)	RGWSTO	Groundwater storage at the end of time step
5	Net Deep Percolation (+)	RNETP	Recharge to the groundwater; this column represents the outflow from the unsaturated layer directly above the aquifer
6	Gain from Stream (+)	RSTINF	Amount of stream flow that contributes to groundwater; stream-groundwater interaction due to a losing stream is defined as a positive value whereas a gaining stream is defined as a negative value
7	Recharge (+)	RRECH	Recharge to the aquifer from injection wells and recoverable loss of diversions and bypasses
8	Gain from Lake (+)	RLAKE	Lake-groundwater interaction; a positive value represents flow from lake into groundwater, a negative value represents flow from groundwater into lake
9	Boundary Inflow (+)	RBOUND	Net inflow into groundwater due to boundary conditions
10	Subsidence (+)	RGWSTOC–RGWSTPC	Amount of flow released out of groundwater storage due to subsidence
11	Subsurface Irrigation (+)	RSUBIRIG	Contribution of subsurface irrigation to groundwater storage
12	Tile Drain Outflow (–)	RGWDRAIN	Groundwater that flows into tile drains
13	Pumping (–)	RPUMP	Total subregional groundwater pumping
14	Net Subsurface Inflow (+)	RSUBFL	Net groundwater inflow into the subregion from the surrounding subregions
15	Discrepancy	RGWERR	Error in the groundwater mass balance based on the preceeding columns
16	Cumulative Subsidence	RGWSTOC	Cumulative volume of groundwater storage lost due to land subsidence

Element Sub-Group Report Unit 5

An element sub-group report is given for each element sub-group specified in the element characteristics pre-processor input file (Unit 13). The report is useful for displaying output for areas that do not encompass a specified subregion. The title of each report includes the IWFM version number, the sub-group number and the unit of output values. The following list defines the columns in this output file:

ELEMENT SUB-GROUP DETAILS

COL. #	COLUMN NAME	VARIABLE	DESCRIPTION
1	Time	IFLAG	Time step
Lands within the Sub-group			
2	Agricultural Supply Requirement	SDMAG	Sub-group agricultural demand
3	Urban Supply Requirement	SDMUR	Sub-group urban demand
4	Return Flow	SRTRN	Return flows from water applied to agricultural and urban lands
5	Deep Percolation	SPERC	Deep percolation of water from the root zone to the unsaturated zone within the sub-group area
6	Runoff	SROFF	Direct runoff of precipitation within the sub-group
Streams within the Sub-group			
7	Return Flow to Streams	SRTST	Return flow into the streams within the sub-group
8	Runoff to Streams	SROST	Direct runoff that flows into streams within the sub-group
9	Gain from Groundwater	-SSTINF	Stream-groundwater interaction within the sub-group; a positive value indicates a gaining stream whereas a losing stream is represented as a negative value
10	Diversion	SRDV	Water diverted from streams within a sub-group

11	Diversion Shortage	SRDVSH	Amount of water unable to fulfill surface water diversion requirements due to insufficient stream flows
Groundwater within Sub-group			
12	Pumping	SPUMP	Total groundwater pumping within a sub-group
13	Ending Storage	SGWST	Volume of groundwater within a sub-group at the end of the time step
14	Cumulative Subsidence	SGWSTC	Cumulative volume of groundwater storage lost due to land subsidence

Small Watershed Flow Components Unit 6

Small stream watersheds surrounding the study domain are modeled as boundary conditions and contribute surface water and groundwater flows to the system. The small stream watershed flow components report provides tables for each small stream watershed modeled. The title for each small watershed includes IWFM version number, small stream watershed identification number and the unit of output values. The following list defines the columns in the report:

SMALL WATERSHED FLOW COMPONENTS

COL. #	COLUMN NAME	VARIABLE	DESCRIPTION
1	Time	IFLAG	Time step
2	Total SW Outflow	SWSUR	Total amount of surface flow from the small stream watershed boundary to the modeled area
3	GW Base Outflow	SWSUB	Total amount of groundwater flow from the small watershed into the modeled area
4	Base Flow + Surface Percolation	SWINF	The sum of the groundwater base outflow from the small watershed boundary and surface flow that percolates to the groundwater while en-route to a stream within the modeled area from the small stream watershed

5	Net Surface Outflow to Streams	SWOFF	Total surface water outflow less the surface percolation

Lake Budget Unit 7

Lakes are modeled to determine their interaction with the groundwater and the stream system. The lake budget provides the lake water balance, lake storage and lake surface elevation at the end of each time interval. The title lines for each lake budget include IWFM version number, lake identification number and the unit of output data. The following list defines the columns in the lake budget:

LAKE BUDGET

COL. #	COLUMN NAME	VARIABLE	DESCRIPTION
1	Time	IFLAG	Time step
2	Beginning Storage (+)	STLAKE_P	Lake storage at the beginning of the time step
3	Ending Storage (–)	STLAKE	Lake storage computed at the end of the time step
4	Flow from Upstream Lake (+)	QUPLKIN	Inflow from lake(s) that are located upstream of the lake
5	Flow from Bypasses (+)	QLKFL	Inflow into the lake from bypasses
6	Precipitation (+)	QLPRCP	Amount of precipitation that falls on the lake surface, which is based on precipitation and the rainfall station(s) associated with lake elements

7	Gain from Groundwater (+)	-RLKINF	Lake-groundwater interaction; a positive value indicates that the flow from the groundwater into the lake, whereas a negative value indicates flow from the lake to the groundwater system
8	Lake Evaporation (–)	QLKEV	Evaporation from the lake surface
9	Lake Outflow (–)	QLKOUT	Spill from lake as the lake surface elevation raises above the maximum lake elevation
10	Discrepancy (=)	RLKERR	Mass balance error for lake
11	Lake surface Elevation	HLAKE	Lake elevation that corresponds to the simulated lake storage

Stream Reach Budget Unit 8

The stream reach budget includes a table for each stream reach modeled that displays the mass balance in a stream reach. The title for each stream reach budget table includes the IWFM version number, stream reach identification number and volumetric units for the values in each column. The stream reach flow components are listed as follows:

STREAM REACH BUDGET

COL. #	COLUMN NAME	VARIABLE	DESCRIPTION
1	Time	IFLAG	Time step
2	Upstream Inflow (+)	RHUFLOW	Inflow at the first upstream node of the reach
3	Downstream Outflow (–)	RHDFLOW	Stream flow leaving the reach and entering another reach

4	Tributary Inflow (+)	RHTRIB	Surface flows from small stream watersheds into the stream reach
5	Tile Drain (+)	RHDRAIN	Tile drain flows into the reach
6	Runoff (+)	RHROST	Direct runoff due to precipitation into the stream reach
7	Return Flow (+)	RHRTST	Return flow of agricultural and urban applied water to a stream reach
8	Gain from Groundwater (+)	-RHSTINF	Amount of water contributed to the reach from groundwater; a positive value represents a net flow from groundwater to the reach, a negative value represents a net flow from reach to the groundwater
9	Gain from Lake (+)	RHRLKIN	Contribution of outflow from upstream lake(s) to the reach
10	Diversion (–)	RHDIVS	Amount of water diverted from the stream reach
11	Bypass Flow (–)	RHBYPS	Net amount of water that is diverted as bypass flow from the stream reach
12	Discrepancy (=)	RHSERR	Error in the reach flow mass balance based on the preceding columns
13	Diversion Shortage	RHDVSH	This column indicates whether the simulated reach flows are sufficient to meet the surface water diversion requirements; a value of zero indicates that reach flows are sufficient to meet the specified diversion requirements; a positive value represents the shortage of flow in a reach

Diversion Detail Report Unit 9

This data file reports surface water deliveries and diversions, as well as the difference between the specified and actual deliveries and diversions for each subregion for all time intervals within the specified beginning and ending time step. The diversion

detail report for the entire model area is not produced. Each report title indicates IWFM version, the area of subregion and the volumetric units associated with the table values.

The row labeled *Diversion #* consists of the diversion identification numbers in the subregion. Diversion identification numbers are specified in the simulation file Unit 25 by the user. A delivery is specified as (+) and a diversion as (–). The row labeled *Stream Node* lists the stream nodes where the diversions originate. A value of zero indicates a stream node outside the model boundary. A delivery is exported out of the model boundary when the stream node associated with the delivery is defined as zero. A diversion is imported from outside the model boundary when a zero value is specified for the corresponding stream node. The values in the table (not in parentheses) are the actual deliveries and diversions at each time interval. The value in parentheses represents the reduction with respect to the diversion and delivery requirements specified in simulation file Unit 26.

5. Running IWFM

Running IWFM is a three step procedure the first time the model is run for a specific application. The pre-processing program is executed to set geometric, hydrologic and stratigraphic characteristics of the model domain. The pre-processing information is used, in conjunction with boundary conditions, initial conditions, and hydrologic data to run the simulation model. The binary output generated from IWFM simulation is then processed into tabular form using the Budget and Z-Budget executable programs. It is not necessary to execute the pre-processor for subsequent runs of a specific study area, given the characteristics of the domain are the same. Simply use the binary file generated in the previous Pre-processor run as input to the new simulation run.

To run IWFM, install a copy of the Pre-processor, Simulation, Budget and Z-Budget executable programs, as well as the input files necessary to run each portion of the program for a specific application. Figure 5.1 is a suggested way to organize your files within a folder structure.

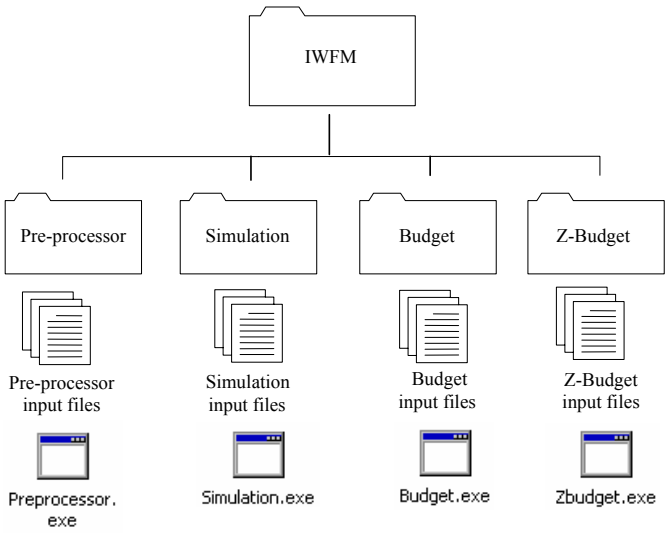
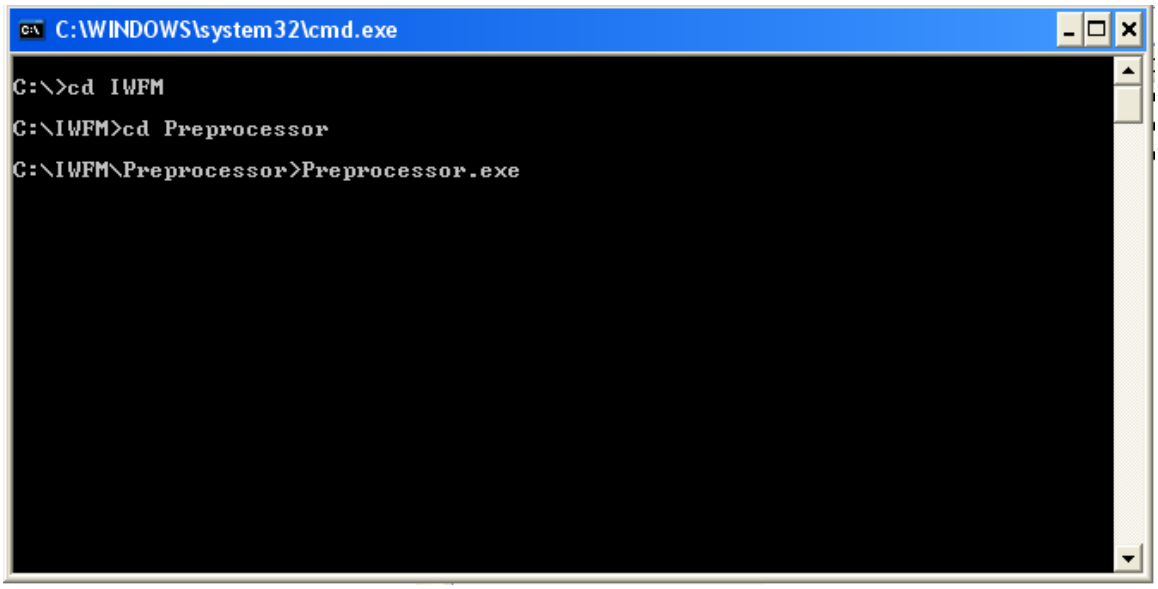
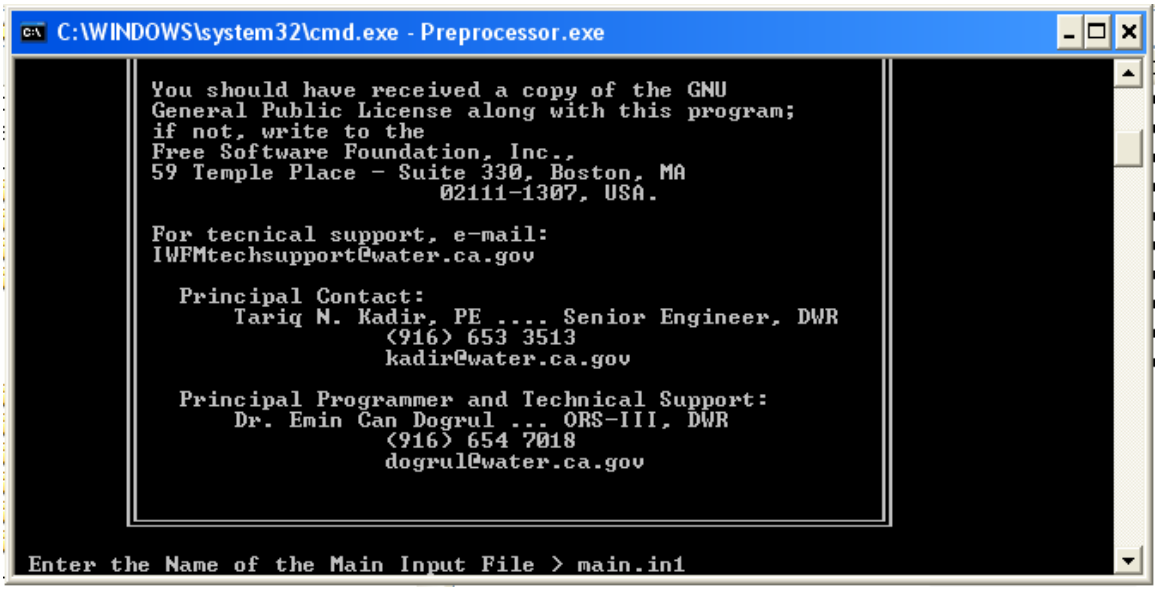


Figure 5.1 Suggested organization of IWFM folder structure

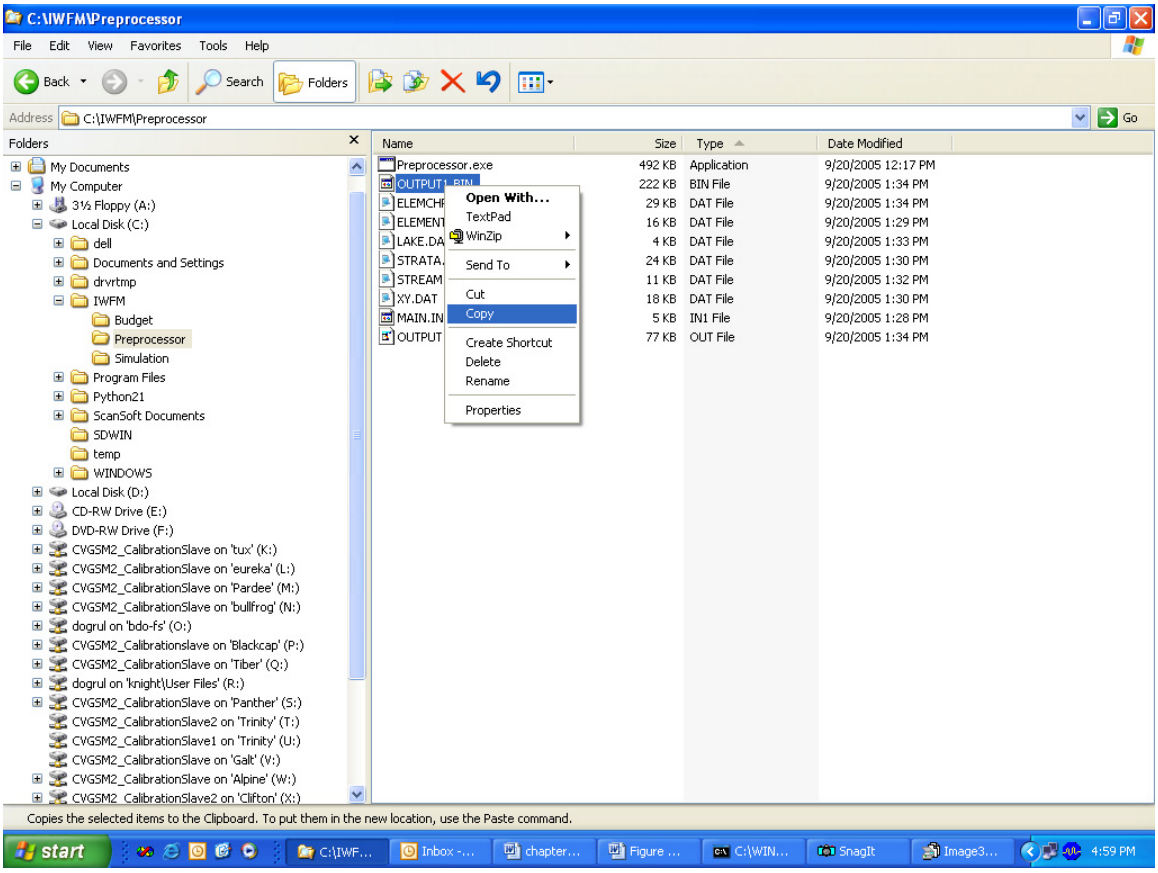
The folder structure illustrated in Figure 5.1 is used in the explanation of how to run IWFM. Once the folder structure is organized, open an MS-DOS prompt window, navigate to the directory that contains the IWFM Pre-processor executable, and enter the executable name.



The Pre-processor will then prompt the user to enter the main input control file.

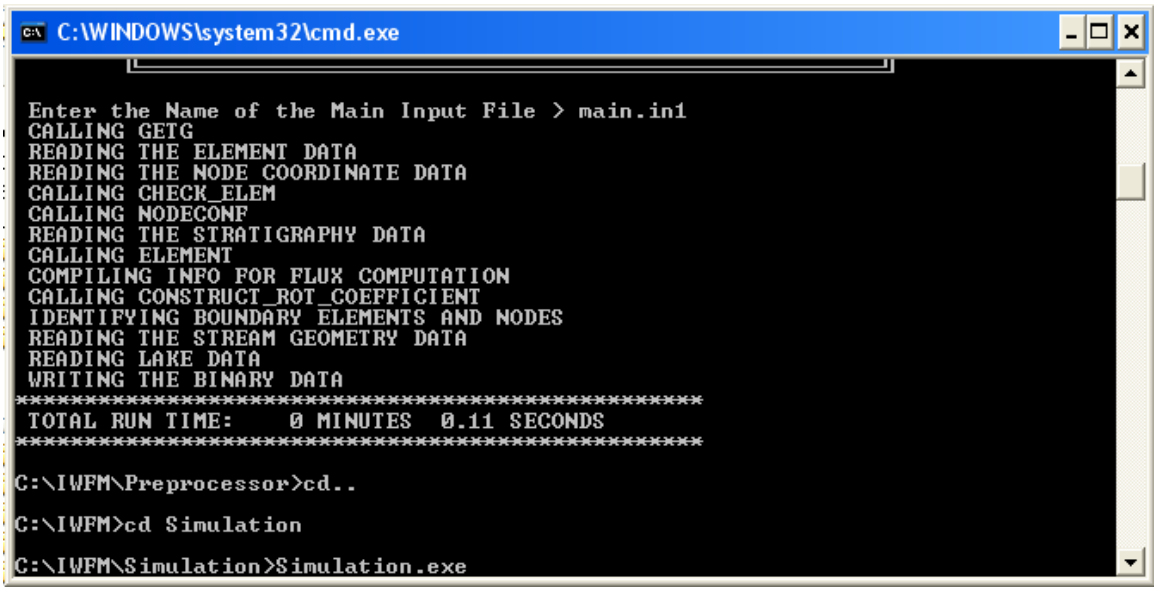


Upon completion of running the Pre-processor, the user must copy the binary output generated to the Simulation folder.

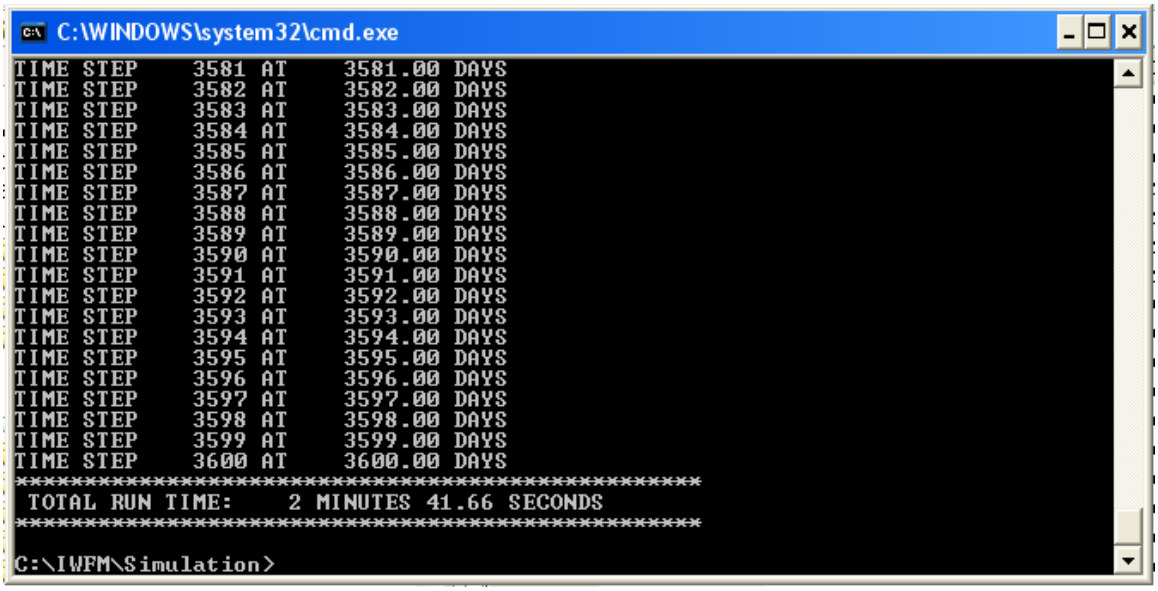


Given that the Simulation folder already includes the executable program and necessary input files, pasting a copy of the binary output file generated from the Pre-processor is the last step before running the simulation portion of IWFM.

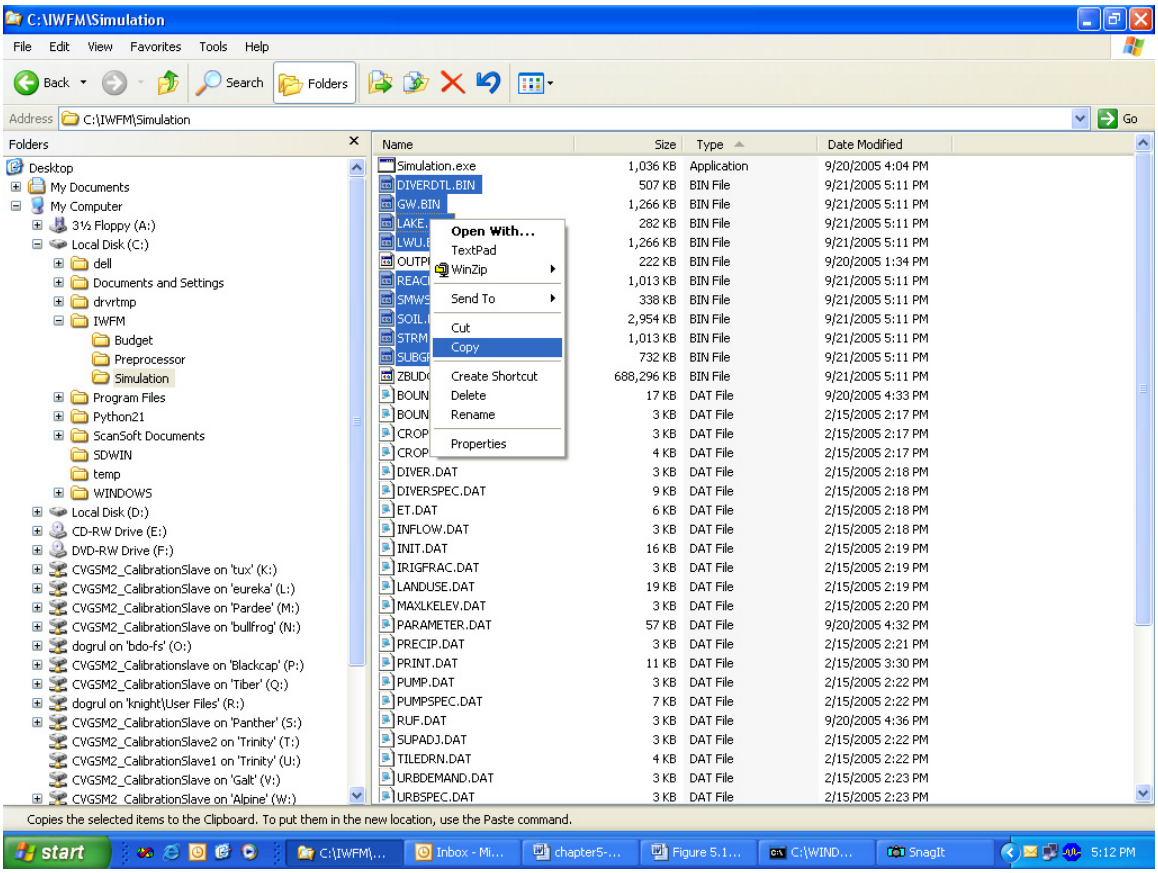
Within the MS-DOS prompt window, navigate to the Simulation folder, and enter the Simulation executable name.



The program then prompts the user to specify the main input file for Simulation. Once Simulation is completed, the program will specify the total run time required for the simulation. Note that the total run time will be specified correctly only when running IWFM on Windows NT, Windows 2000 and Windows XP operating systems.



The next step is to process the information generated from Simulation into tables. Copy relevant binary files generated in the Simulation and paste them into the Budget and Z-Budget folders, as shown below.



Running the Budget and Z-Budget is done in the same manner as running the first two portions of the IWFM. The user must navigate to the relevant folder (that contains the files necessary to run the executable), execute the program, and provide the main input file name. The Budget and Z-Budget executable programs organize and tabulate the Simulation output.

Compilation of IWFM requires all source code and a Fortran compiler. The California Department of Water Resources (DWR) has used Compaq Visual Fortran Version 6.6C for the development and testing of this version of IWFM and supplies technical support on this version. However, DWR does not provide technical support for versions of IWFM modified by other users.